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UNIVERSITY OF PENNSYLVANIA.

# HANDBOOK OF INFORMATION

CONCERNING

# THE SCHOOL OF BIOLOGY.

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1889

BIOLOGICAL LABORATORY.

UNIVERSITY OF PENNSYLVANIA.

# HANDBOOK OF INFORMATION

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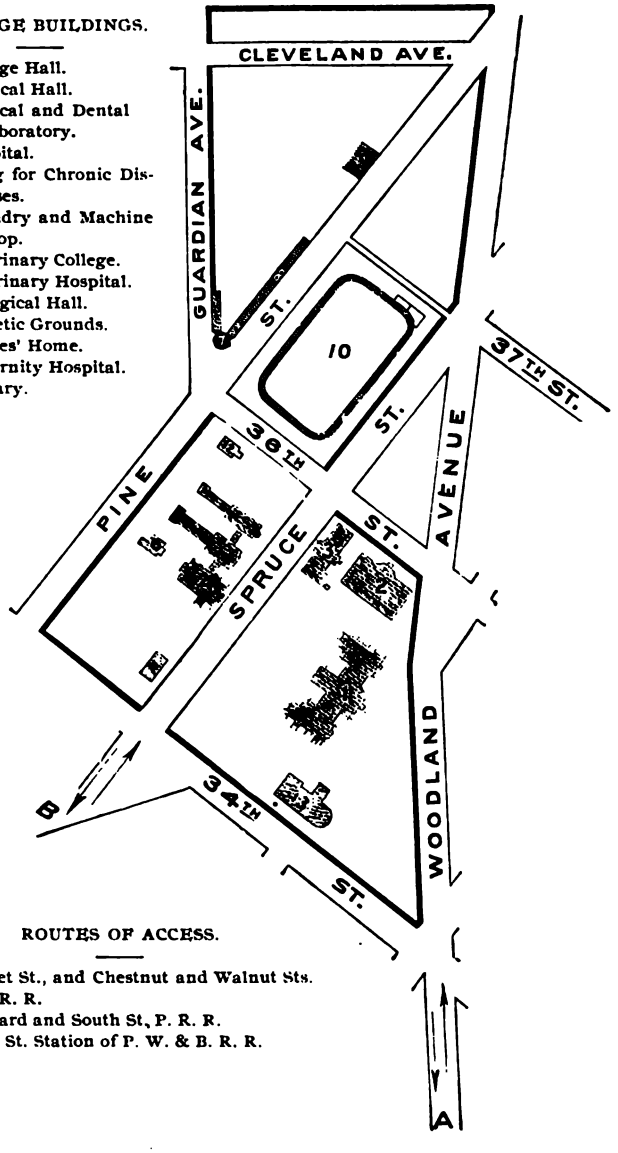


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A PAMPHLET, called: *Proposals Relative to the Education of Youth in Pennsylvania*, written in 1749 by Dr. FRANKLIN, led to an association, by certain citizens of Philadelphia, for the purpose of founding a School on the lines suggested by that wise counsellor. Over two thousand pounds, equivalent to at least forty thousand dollars at the present time, were raised; a building, which had been erected to accommodate the thronged congregations of the celebrated Whitfield, was purchased; and in 1751 the Academy, consisting of an English, a Mathematical and a Latin School, each under a Master, with subordinate tutors and ushers, was formally opened. So successful was the undertaking that in two years the Trustees applied to the Proprietaries for a Charter, which was granted in 1753, creating The Trustees of the Academy and Charitable School in the Province of Pennsylvania.

Under the skilful training of the learned Rev. William Smith the highest class in this Academy attained that proficiency which, in a College course, would entitle it to a Degree. Accordingly, two years later the Proprietaries were again petitioned to convert the Academy into a College, with the power of conferring Collegiate Degrees. The petition was granted, and *The College and Academy of Philadelphia, in the Province of Pennsylvania*, created by an additional charter issued in 1755.

The First Commencement was held May 17th, 1757, when Paul Jackson, Jacob Duchè, Francis Hopkinson, Samuel Magaw, Hugh Williamson, James Latta and John Morgan received the

Degree of Bachelor of Arts. In the agitated times that followed, during the wars with the French, the Provost, Mr. Smith, opposed so vehemently the non-resistance policy of the Legislature of Pennsylvania, that by an arbitrary stretch of power he was thrown into prison. In faithfulness to his duties as Provost, however, he received his classes in gaol, and continued his instructions to them there while still a prisoner. Finally he was set at liberty, for the purpose of going to England to make a personal appeal to the king, and his kindly reception there was not lessened by the strain to which his loyalty at home had been put. Oxford conferred on him the Degree of Doctor of Divinity. On his return home so highly did his fellow-citizens rate his influence abroad, that when in 1761 the Trustees were hard bestead they sent him back to England to raise funds for an endowment. It happened that King's College (now Columbia) in New York was in similar straits and had resolved on similar efforts. The two commissioners met in England and amicably resolved to "divide the land between them," and share the proceeds. Through the influence of the Archbishop of Canterbury they received a circular letter from the king to all churches, and succeeded in raising a very considerable endowment for each college.

On Dr. Smith's return, as it appears on the minutes of the 14th of June, 1764, a letter was received from the Archbishop of Canterbury, Thomas and Richard Penn, and the Rev. Samuel Chandler, D.D., addressed to the trustees, in which the trustees are congratulated on the success of Dr. Smith's, the provost's, collection in England, and advised of what would be further necessary to the due improvement of the collection and the future prosperity of the institution. "That the institution was originally founded and carried on for the general benefit of a mixed body of people—that on the king's brief it is represented

as a seminary that would be of great use for securing capable instructors and teachers, as well for the service of the society for propagating the gospel in foreign parts, as for other protestant denominations in the colonies.—That at the time of making the collection, the provost was a clergyman of the Church of England—the vice-provost, a Presbyterian—a principal professor, a Baptist, with other useful professors and tutors, all carrying on the education of youth with great harmony, and people of various denominations have heretofore contributed liberally and fully.—That jealousies had arisen lest the foundation should be narrowed, and some party exclude the rest, or put them on a worse footing than they have been or were at the time of the collection, which would be unjust and productive of contentions unfriendly to religion. It was therefore recommended to the trustees, by the writers of the letter (who had a principal share in procuring the collection), to make a fundamental rule or declaration, to prevent inconvenience of this kind, and in doing which, they were advised that the more closely they kept in view the plan on which the seminary was at the time of the royal brief, and on which it was carried on from the beginning, so much the less cause would any party have to be dissatisfied."

A committee having been appointed to frame a fundamental *Resolve* or declaration, in consequence of the letter, the following was reported and adopted:

"The trustees being ever desirous to promote the peace and prosperity of this seminary, and to give satisfaction to all its worthy benefactors, have taken the above letter into their serious consideration, and, perfectly approving the sentiments therein contained, do order the same to be inserted in their books, that it may remain perpetually *declaratory* of the present *wide* and excellent plan of this institution, which hath not only met

with the approbation of the great and worthy personages above mentioned, but even the royal patronage of his majesty himself. They further *declare* that they will keep this plan closely in their view, and use their *utmost endeavors* that the same *be not narrowed*, nor the members of the church of England, or those dissenting from them (*in any future election to the principal offices mentioned in the aforesaid letter*), be put on *any worse footing* in this seminary, than they were *at the time of obtaining the royal brief*. They subscribe this with their names, and ordain that the same be read and subscribed by every new trustee that shall hereafter be elected, before he takes his seat at the board."

Perhaps no more striking instance can be given of the distortion to which men's minds were subject in those days of political commotion than the fact that in 1779 this resolution was construed by the Legislature into a "narrowing of the foundation," and seized as a pretext for confiscating all the rights and properties of the College, which were bestowed upon a new organization called in its charter the "Trustees of the University of the State of Pennsylvania." Ten years later, these rights and properties were all restored, and in 1791 an act was passed amalgamating the old College in the new University, as follows:

WHEREAS, the trustees of the University of the State of Pennsylvania, and the trustees of the College, Academy, and Charitable School of Philadelphia, in the commonwealth of Pennsylvania, by their several petitions have set forth, that they have agreed to certain terms of union of the said two institutions, which are as follows:

*First.* That the name of the institution be "*The University of Pennsylvania*," and that it be stationed in the city of Philadelphia.

*Second.* That each of the two boards shall elect, from among themselves, twelve persons, who, with the governor for the time

being, shall constitute the board of trustees of the university of Pennsylvania; and that the governor shall be president.

SECT. 2. *And be it further enacted*, That the said twenty-four persons so elected and certified, together with the governor for the time being, who shall always be president, and their successors be, and they are hereby made and constituted a corporation and body politick, in law and in fact, to have continuance for ever by the aforesaid name, style, and title of "The Trustees of the University of Pennsylvania," and that the said university shall at all times be stationed in the city of Philadelphia.

Thus established, the University has advanced with the times, and now comprises the following departments:

- THE COLLEGE DEPARTMENT, including
  - THE COURSE IN ARTS,
  - THE COURSES IN SCIENCE,
    - (The Towne Scientific School).
  - THE COURSE IN NATURAL HISTORY,
    - (The School of Biology).
  - THE COURSE IN PHILOSOPHY FOR UNDERGRADUATES.
  - THE COURSE IN FINANCE AND ECONOMY,
    - (The Wharton School).
  - THE COURSE IN MUSIC.
- THE DEPARTMENT OF MEDICINE.
- THE DEPARTMENT OF LAW.
- THE AUXILIARY DEPARTMENT OF MEDICINE.
- THE DEPARTMENT OF DENTISTRY.
- THE DEPARTMENT OF PHILOSOPHY.
- THE DEPARTMENT OF VETERINARY MEDICINE.
- THE DEPARTMENT OF PHYSICAL EDUCATION.

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HARRY H. KYNETT, M.D.,
Acting Assistant Demonstrator of Anatomy.

JOHN C. HEISLER, M.D.,
Prosector to the Professor of Anatomy.

CHARLES B. PENROSE, M.D.,
Instructor in Clinical Surgery.

WALTER D. GREENE, M.D.,
Assistant Demonstrator of Surgery.

WALTER CHRYSTIE, M.D.,
Instructor in Physical Diagnosis.

FREDERICK A. PACKARD, M.D.,
Instructor in Physical Diagnosis.

EDGAR KIDWELL, A.M., M.E.,
Instructor in Dynamical Engineering. University.

DANIEL B. SHUMWAW, A.B.,
Instructor in English. 1740 Green St.

JOHN G. FULLER, D.D.S.,
Assistant Demonstrator of Mechanical Dentistry. 208 N. 34th St.

CHARLES A. E. CODMAN, D.D.S.,
Assistant Demonstrator of Operative Dentistry. 3733 Spruce St.

FREDERIC A. PEESO, D.D.S.,
Demonstrator of Crown and Bridge Work.

JOHN D. THOMAS, D.D.S.,
Lecturer on Nitrous Oxide. 912 Walnut St.

OTTO REUNIG,
Clerk to the College Faculty.

WILLIAM H. SALVADOR,
Clerk to the Faculty of Medicine.

JOHN A. REIMOLD,
Clerk to the Faculty of Dentistry.

BARCELONA BASS,
Clerk to the Faculty of Biology.

WEST SIDE OF ENTRANCE HALL, SHOWING CLERK'S OFFICE, PHYSIOLOGICAL AND HISTOLOGICAL LABORATORIES.

# THE SCHOOL OF BIOLOGY.

# THE SCHOOL OF BIOLGOY.

## FACULTY.

WILLIAM PEPPER, M.D. (Pennsylvania), LL.D. (Princeton), Provost and ex-officio President.

JOSEPH LEIDY, M.D. (Pennsylvania), LL.D. (Harvard), Professor of Zoology and Comparative Anatomy, *Director*.

JOSEPH T. ROTHROCK, B.S. (Harvard), M.D. (Pennsylvania), Professor of Botany.

HORACE JAYNE, M.D. (Pennsylvania), Professor of Vertebrate Morphology, *Dean*.

JOHN A. RYDER, PH.D. (Pennsylvania), Professor of Comparative Embryology.

WILLIAM P. WILSON, B.S. (Harvard), Sc.D. (Tübingen), Professor of Anatomy and Physiology of Plants, *Secretary*.

CHARLES S. DOLLEY, M.D. (Pennsylvania), Professor of General Biology.

JAMES MCKEEN CATTELL, PH.D. (Leipzig), Professor of Psychology.

INSTRUCTORS.

HOBART A. HARE, M.D. (Pennsylvania), Instructor in Physiology.

EMILY L. GREGORY, PH.D. (Zurich), Fellow in Biology.

MILTON J. GREENMAN, Ph.B. (Pennsylvania), Assistant Instructor in General Biology.

CHARLES M. BURK, Assistant Instructor in Zoology.

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All communications should be addressed to HORACE JAYNE, M.D., Dean of the College Faculty, University of Pennsylvania, Philadelphia, Penna.

This school was organized in 1884 to provide courses of instruction in the different branches of Biological Science. The instruction given by the Faculty of Biology is of two grades: undergraduate and post-graduate. The undergraduate instruction in Biology is under the general control of the undergraduate or College Department. It forms the principal subject in the College Course in Natural History and in the special two years' Course Preparatory to the study of Medicine, and is elective in the classical, literary and general scientific courses. The graduate instruction is part of that offered by the Department of Philosophy to students already possessing a Bachelor's Degree.

# THE COURSES IN BIOLOGY.

## OFFERED FOR 1889–90.

### GENERAL BIOLOGY.

1. General Biology: Lectures and Laboratory work. Six hours. Professor Dolley.

### ZOOLOGY.

2. General Zoology of Invertebrates: Lectures. One hour. (First Term.) Professor Leidy.

3. Systematic Study of the Invertebrates: Laboratory work with Explanatory lectures. Six hours. (First Term.) Professor Dolley.

Course 3 is open to those only who have taken Course 1 and are taking Course 2.

4. General Zoology of Vertebrates: Lectures. One hour. (Second Term.) Professor Leidy.

5. Systematic Study of the Vertebrates. Laboratory work with Explanatory lectures. Six hours. (Second Term.) Professor Jayne.

Course 5 is open to those only who have taken Courses 1 and 3 and are taking Course 4.

6. Animal Histology: Lectures and Laboratory work. Seven hours. (First Term.) Professor Ryder.

Course 6 is open to those only who have taken Course 1.

7. Animal Embryology: Lectures and Laboratory work. Seven hours. (Second Term.) Professor Ryder.

Course 7 is open to those only who have taken Course 6.

8. Mammalian Anatomy: Lectures and Laboratory work. Seven hours. (Second Term.) Professor Jayne.

9. Animal Histology: (Advanced Course.) Lectures

and Laboratory work. Seven hours. (First Term.) Professor Ryder.

Course 9 is open to those only who have taken Course 6.

10. Animal Embryology: (Advanced Course.) Lectures and Laboratory work. Seven hours. (Second Term.) Professor Ryder.

Course 10 is open to those only who have taken Course 7.

11. Invertebrate Morphology: (Advanced Course.) Lectures and Laboratory work. Seven hours. (Second Term.) Professor Dolley.

Course 11 is open to those only who have taken Courses 2 and 3.

12. Vertebrate Morphology: (Advanced Course.) Lectures and Laboratory work. Seven hours. (First Term.) Professor Jayne.

Course 12 is open to those only who have taken Courses 4 and 5.

13. Osteology of the Mammalia: Lectures and Laboratory work. Seven hours. (First Term.) Professor Jayne.

Course 13 is open to those only who have taken Courses 4 and 5.

## BOTANY.

14. General Structural Botany Lectures and Laboratory work. Five hours. (First Term.) Professor Wilson.

Course 14 is open to those only who have taken Course 1.

15. Systematic Study of the Phænogams: Lectures and Laboratory work. Five hours. (Second Term.) Professor Rothrock.

Course 15 is open to those only who have taken Course 14.

16. Plant Histology: Lectures and Laboratory work. Seven hours. (First Term.) Professor Wilson.

Course 16 is open to those only who have taken Course 14.

17. Systematic study of Cryptogams. Lectures and

Laboratory work. Seven hours. (Second Term.) Professor Rothrock.

Course 17 is open to those only who have taken Course 1.

Courses 15 and 17 may be taken together.

18. Plant Physiology: Lectures and Laboratory work. Seven hours. (First Term.) Professor Wilson.

Course 18 is open to those only who have taken Courses 14 and 16.

19. Economic Botany. Lectures and Laboratory work. Seven hours. (Second Term.) Professor Rothrock.

Course 19 is open to those only who have taken Courses 14 and 15.

## PHYSIOLOGY.

20. Animal Physiology: Lectures and Demonstrations. Two hours. Dr. Hare.

Course 20 is open to those only who have taken Course 1.

(The laboratory is open to advanced students.)

## PSYCHOLOGY.

1. Scientific Methods in Psychology: Lectures with Laboratory work. Two hours. (First Term.) Professor Cattell.

2. Experimental Psychology: Lectures with Laboratory work. Two hours. (Second Term.) Professor Cattell.

3. Special Psychological Problems: Lectures with Research in Laboratory. Two hours. (Second Term.) Professor Cattell.

4. Comparative, Social and Abnormal Psychology: Lectures with Laboratory work. Two hours. (First Term.) Professor Cattell.

5. Advanced Psychology. Two hours. Professor Cattell.

## COURSES IN BIOLOGY, 1889–90,

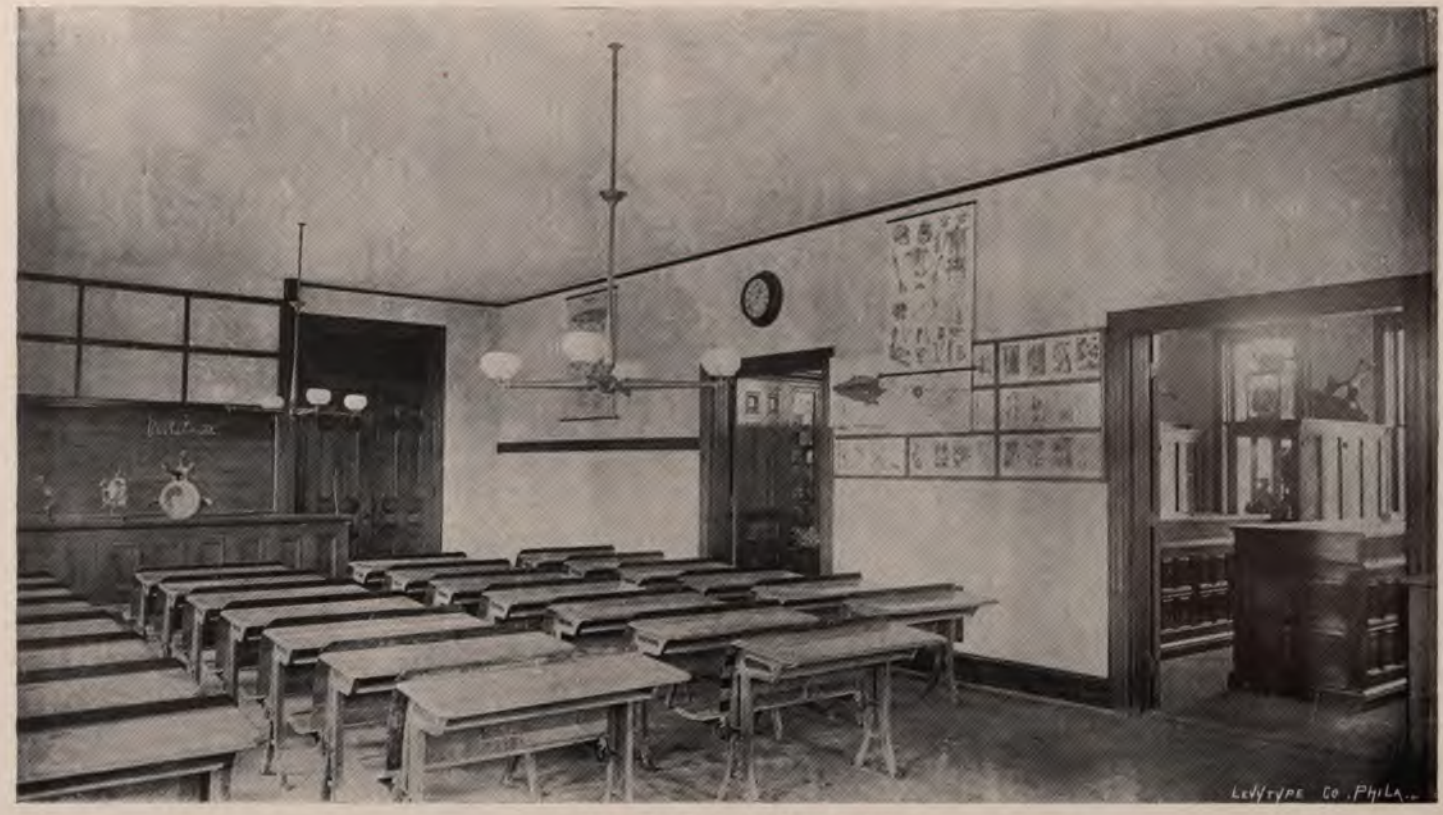
### Arranged by Terms.

*First Term.*

General Biology, [6] Professor Dolley.
Zoology, [1] Professor Leidy.
Invertebrate Morphology, [6] Professor Dolley.
Vertebrate Morphology (Advanced), [7] Professor Jayne.
Histology, [7] Professor Ryder.
Histology (Advanced), [7] Professor Ryder.
Physiology, [2] Dr. Hare.
Scientific Methods in Psychology, [2] Professor Cattell.
Comparative Psychology, [2] Professor Cattell.
Advanced Psychology, [2] Professor Cattell.
Structural Botany, [5] Professor Wilson.
Plant Histology, [7] Professor Wilson.
Plant Physiology, [7] Professor Wilson.

*Second Term.*

General Biology, [6] Professor Dolley.
Zoology, [1] Professor Leidy.
Vertebrate Morphology, [6] Professor Jayne.
Invertebrate Morphology (Advanced), [7] Professor Dolley.
Embryology, [7] Professor Ryder.
Embryology (Advanced), [7] Professor Ryder.
Mammalian Anatomy, [7] Professor Jayne.
Physiology, [2] Dr. Hare.
Experimental Psychology, [2] Professor Cattell.
Special Psychological Problems, [2] Professor Cattell.
Advanced Psychology, [2] Professor Cattell.
Systematic Botany (Phænogams), [5] Professor Rothrock.
Systematic Botany (Cryptogams), [7] Professor Rothrock.
Economic Botany, [7] Professor Rothrock.




LECTURE ROOM AND MUSEUM.

# UNDERGRADUATE INSTRUCTION.

The courses in Biology have been selected and combined with other general branches to form two definite plans of study: one of four years, called the College Course in Natural History, with entrance examinations and leading to the degree of Bachelor of Science (B.S.), the other of two years—Preparatory to Medicine—to enter which no formal examinations are required, although the student must satisfy the Faculty of his ability to pursue the work intelligently. All the college courses are open to special and partial students, subject to certain restrictions.

## THE COURSE IN NATURAL HISTORY.

### REQUIREMENTS FOR ADMISSION.

Candidates for the Freshmen Class are admitted to college either on certificate or by examination. Blank certificates are issued every year to such principals of recognized preparatory schools and to such private teachers as may be named for the privilege. The Faculty reserves the right, however, to withdraw from any school or teacher the privilege of sending pupils into college on certificates.

Entrance examinations on the following subjects are held in June and September. (Circulars stating the days and the

subjects for examination for each day can be had, after April 1st, on application to the Dean of the College Faculty.)

PRESCRIBED STUDIES.

ENGLISH.—1st. A short composition, correct in spelling, punctuation, grammar, division by paragraphs, and expression, on one of several subjects to be announced at the time of the examination, and to be taken from the last-named of the following books, all of which (or the last-named and equivalents for the first three) must have been read by each candidate, viz., Shakespeare's *As You Like It* and *Midsummer Night's Dream*, Scott's *Rob Roy*, and Thackeray's *English Humorists*. 2d. Questions on the grammar, etymology and subject-matter of a passage to be taken from the same book as the subjects of composition are taken from. 3d. The correction of specimens of English bad in grammar or expression, with a brief statement of the principles on which the correction is made.

The following books indicate the amount and kind of knowledge required to pass this examination, viz., Abbott's *How to Parse*, or Murray's *Advanced Lessons in English Composition, Analysis and Grammar;* Strang's *Exercises in English;* McElroy's *Essential Lessons in English Etymology* (Chh. I.–III. and V.): and Williams's *Composition and Rhetoric by Practice*.

In 1890, the books to be read by each candidate will be Scott's *Quentin Durward*, Thackeray's *English Humorists*, Shakespeare's *Midsummer Night's Dream*, and Goldsmith's *Deserted Village;* in 1891, Scott's *Quentin Durward*, Goldsmith's *Deserted Village*, Shakespeare's *Merchant of Venice*, and Irving's *Bracebridge Hall*.

HISTORY A.—Ancient History (Freeman's *General Sketch of History*, Chaps. I.–VI.). History of the United States. (Scudder or Johnston is suggested.)

MATHEMATICS A.—Arithmetic (including the Decimal System of weights and measures). Algebra (through Quadratic Equations). Plane Geometry.

ELECTIVE REQUIREMENTS.

LATIN B.—Grammar. Cæsar (Four Books of the Gallic War). Virgil (Six Books of the Æneid). Cicero (Six Orations). Prose Composition (as in Arnold's Latin Prose Composition to the end of Exercise 20).

LATIN A.—Cæsar (Commentaries, three books). Virgil (three books of the Æneid). Latin Prose Composition.

GREEK.—Grammar Prose Composition (White's First Lessons cover the amount required). Xenophon (four books of the Anabasis). Homer (three books of the Iliad or of the Odyssey).

FRENCH.—Grammar (as much as is indicated by the first forty-five Practical Exercises appended to Harrison's French Syntax). Telèmaque (the first three books or an equal amount of matter from any good modern prose author).

GERMAN.—Ahn's method. Fisher's Edition. (First course, pp. 1–100; second course, pp. 1–64.) Grimm's Maerchen (Otis' Edition).

MATHEMATICS B.—Solid Geometry.

MATHEMATICS C.—Algebra, Plane and Spherical Trigonometry. Solid Geometry or Analytical Geometry.

HISTORY B.—English History.

ENGLISH B.—The Equivalent of the Work of the Freshman Year in English, and English Literature. At least a year's study in addition to English A.

PHYSIOLOGY.—Martin's Human Physiology.

BOTANY.—Bessey's Briefer Course in Botany covers the amount required.

ZOOLOGY.—Claus and Sedgwick's Zoology.

PHYSICAL GEOGRAPHY.—

ASTRONOMY.—Lockyer's Elementary Lessons, or equivalent. A knowledge of the principal constellations will be required.

CHEMISTRY. — Sheppard's General Chemistry or Remsen's Elementary Chemistry.

PHYSICS.—Avery's Elements of Natural Philosophy or Gage's Elements of Physics.

GEOLOGY.—Candidates who offer Geology must show a satisfactory field knowledge of the formations found in the locality of their previous residence. They must be able to identify the rocks occurring at such locality from specimens shown them, and recognize the fossil animal forms of such as are found in the rocks, and to give their general zoological characters.

The Requirements for Admission must be presented in accordance with one of the following three plans:

1. English A.
2. History A.
3. Mathematics A.

And one of the following groups:

| I. | II. | III. |
|---|---|---|
| 4. Latin B. and<br>5. Greek. | 4, 5. Two of the following:<br>Latin A.<br>French<br>German and<br>6. Mathematics B. | 4. English B. and<br>5. Physical Geography and<br>6, 7, 8, 9. Four of the following:<br>Latin A. Physiology.<br>Mathematics C. Geology,<br>History B. Physics,<br>Botany, Chemistry,<br>Zoology, Astronomy. |

## PRELIMINARY EXAMINATIONS.

Candidates who wish to do so may be examined one year in advance of their entering college in any or all of the following subjects, viz.: English Grammar, History of the United States, Arithmetic, Algebra (subjects contained in the first eleven chapters of Wentworth), and Plane Geometry, Greek Grammar, Greek Prose Composition and Xenophon, Latin Grammar, Latin Prose Composition and Virgil, French Grammar and German Grammar. A record will be kept of these examinations and credit be given for such of them as are passed satisfactorily. Preliminary examinations are ordinarily held only in June.

## EXAMINATIONS FOR ADVANCED STANDING.

Candidates must pass satisfactorily in all the subjects pursued by the lower class or classes; but students coming with letters of honorable admission from other colleges, and showing that they have pursued successfully courses of study equivalent to those taken by the classes they wish to enter, are admitted without examination.

Duly authenticated graduates of other colleges are admitted without examination to any of the courses upon giving evidence that their studies have been such as to fit them to pursue the particular course for which they apply.

## COURSE OF STUDY.

### FRESHMAN YEAR.

| *First Term.* | *Second Term.* |
|---|---|
| English (3) * | English (3) |
| History (2) | History (2) |
| Mathematics (5) | Mathematics (5) |
| Latin or German or French † | Latin or German or French |
| Drawing (3) | Drawing (3) |
| General Biology (6) | General Biology (6). |

### SOPHOMORE YEAR.

#### PRESCRIBED STUDIES.

| *First Term.* | *Second Term.* |
|---|---|
| English (2) | English (2) |
| Latin or German or French | Latin or German or French. |

#### ELECTIVE STUDIES.‡

| | |
|---|---|
| English Literature (2) | English Literature (2) |
| Mathematics (3) | Mathematics (3) |
| History (3) | History (3) |
| Chemistry (5) | Chemistry (5) |
| Physics (4) | Physics (4) |
| Zoology (1) | Zoology (1) |
| Invertebrate Morphology (6) | Vertebrate Morphology (6) |
| Structural Botany (5) | Systematic Botany, Phænogams (5). |

* The numerals indicate the hours of instruction per week.

† Before completing this course each student must have taken of one or more of these languages an equivalent of twelve hours a week for one year. The languages selected and the order in which they can be taken will depend on the language or languages offered at the entrance examinations. Students who offer no foreign languages for admission must take of Latin the equivalent of six hours a week for one year.

‡ Of the elective studies each student must take each year enough courses to make his total number of hours per week, including required work, not less than twenty.

JUNIOR YEAR.

| *First Term.* | *Second Term.* |
|---|---|
| PRESCRIBED STUDIES. | |
| English Themes. | English Themes. |
| Latin or German or French. | Latin or German or French. |
| ELECTIVE STUDIES. | |
| The electives offered in the Sophomore Year and in addition: | |
| English Literature (2) | English Literature (2) |
| History (2) | History (2) |
| Philosophy (4) | Philosophy (4) |
| Psychology (4) | Psychology (4) |
| Mineralogy (4) | Mineralogy (4) |
| Physics (4) | Physics (4) |
| Inorganic Chemistry (7) | Inorganic Chemistry (7) |
| Histology (7) | Embryology (7) |
| Structural Botany (7) | Systematic Botany, Cryptogams (7). |

SENIOR YEAR.

| *First Term.* | *Second Term.* |
|---|---|
| PRESCRIBED STUDIES. | |
| English Themes. | English Themes. |
| Political Economy (2) | Political Economy (2) |
| Latin or German or French. | Latin or German or French. |
| ELECTIVE STUDIES. | |
| All the electives offered for the Junior Year and in addition. | |
| Geology (4) | Geology (4) |
| Physiology (2) | Physiology (2) |
| Organic Chemistry (6) | Organic Chemistry (6). |
| And the following advanced courses: | |
| History (2) | History (2) |
| English Literature (2) | English Literature (2) |
| Philosophy (4) | Philosophy (4) |
| Psychology (4) | Psychology (4) |
| Physics (3) | Physics (3) |
| Vertebrate Morphology (7) | Invertebrate Morphology (7) |
| Mammalian Osteology (7) | Mammalian Anatomy (7) |
| Histology (7) | Embryology (7) |
| Physiological Botany (7) | Economic Botany (7). |

EAST END OF HISTOLOGICAL LABORATORY HALL, AND MUSEUM.

## THE COURSE PREPARATORY TO MEDICINE.

This course was established in 1885 for earnest students who cannot present the requirements for admission to the regular college courses, or are unable to devote four years to preparatory work, and yet desire some systematic training in scientific and liberal studies. The results have already shown conclusively that such a course was greatly needed, and that the men who have faithfully pursued the work have excelled in their subsequent professional studies.

### First Year.

| *First Term.* | *Second Term.* |
|---|---|
| English (3)* | English (3) |
| History (2) | History (2) |
| Latin or German or French (4) | Latin or German or French (4) |
| Drawing (3) | Drawing (3) |
| Chemistry (5) | Chemistry (5) |
| General Biology (6) | General Biology (6) |
| Mineralogy (2) | Mineralogy (2). |

### Second Year.

| *First Term.* | *Second Term.* |
|---|---|
| Latin or German or French (4) | Latin or German or French (4) |
| Chemistry (7) | Chemistry (7) |
| Geology (2) | Geology (2) |
| Zoology (1) | Zoology (1) |
| Invertebrate Morphology (6) | Vertebrate Morphology (6) |
| Histology (7) | Embryology (7) |
| Structural Botany (5) | Systematic Botany (5) |
| Physiology (2) | Physiology (2). |

## SPECIAL AND PARTIAL COURSES.

Students who do not desire to pursue either the four years' Course in Natural History, or the two years' Course Prepara-

* The numbers indicate the hours of instruction per week.

tory to Medicine, may take special or partial courses in any subject or subjects taught in this school. To enter a Special Course a student must satisfy the professor teaching the subject that he is competent to profit by his instruction. With the special subject he must take at least two other subjects. At the close of such a special course, a certificate of proficiency in the subject elected will be granted, signed by all the professors whose instruction the student has attended.

Partial Courses also may be taken, consisting of such groups of studies (not constituting special courses), as the student may select. A certificate, stating what studies have been pursued, will be awarded to those who complete such a course satisfactorily.

In selecting studies to constitute a special or partial course the student is limited to those branches which his previous training qualifies him to pursue, and he must observe any restrictions that may be attached to the particular courses and avoid conflict on the roster.

Special and Partial students are subject to all the regulations of the College, and the Faculty reserves the right to deprive such students of their privileges at any time if they abuse or fail to use them.

## SCHOLARSHIPS.

I. The Penn Scholarships, two in number, are filled by the Governor of the State from time to time as vacancies occur. They exist by virtue of a privilege reserved by Thomas Penn, Proprietary of Pennsylvania.

II. Certain Free Scholarships (about five in each class) are granted to deserving and needy students in this Department, under the following regulations:

Each candidate must present to the Dean of the Faculty,

at or before the entrance examinations in June or September, written testimonials as to his deserts and needs. After passing his examinations satisfactorily, he will be recommended for admission to the Committee of the Board of Trustees. The scholarships are granted for one year only.

III. THE PUBLIC SCHOOL PRIZE SCHOLARSHIPS.—Under a contract with the City of Philadelphia, Fifty Free Scholarships have been permanently established in the College Department of the University for the benefit of pupils from the Public Schools of the city. The candidates for these scholarships are examined by the Board of Public Education, and the scholarships, according to the number of vacancies, are bestowed upon those who reach the highest grade in their examination, provided that grade be at least sixty-five per cent.

Of these, THE BENJAMIN FRANKLIN SCHOLARSHIPS, three in number, and the SAMUEL V. MERRICK SCHOLARSHIP have been endowed.

IV. The income of the BLOOMFIELD MOORE FUND is intended to enable women (not exceeding six in any year) who are teaching, or who propose to teach, to receive free instruction in all departments to which women are admitted.

## PRIZES.

The following prizes are offered annually to students in the College Department.

I. THE FACULTY PRIZES:

1. A prize of thirty dollars for the best Essay in Intellectual and Moral Philosophy by a member of the Senior Class. Subject: *The Monadology of Leibnitz.*

2. A prize of twenty dollars for the best examination on the *Oration of Demosthenes on the Crown* by a member of the Junior Class.

3. A prize of ten dollars for the best examination by a member of the Freshman Class on Greek Prose Composition with the Accents.

4. A first prize of fifteen dollars, and a second prize of ten dollars, for the best examination on the *Lectures on Quaternions* given to the Voluntary Junior Class.

5. A prize of thirty dollars for the best Essay in History and English Literature by a member of the Senior Class. Subject: The Alleged Decadence of Public Life in America since 1789.

6. A prize of twenty dollars for the best Essay by a member of the Junior Class. Subject: *The Literary Essays of Matthew Arnold.*

7. A prize of fifteen dollars for the best Declamation by a member of the Sophomore Class.

8. A first prize of fifteen dollars, and a second prize of ten dollars, for the best special examinations in the elements of Latin Prose Composition by Freshmen on entering College. In 1889, the examination will be upon the first fifty-five exercises in *Arnold's Latin Prose Composition.* Certificates will be presented to *all* competitors whose examinations reach a satisfactory standard.

9. Two prizes of the same value as those offered for Latin Prose Composition, for the best special examinations in Greek Prose Composition by Freshmen on entering College. In 1889, the examination will be on *Jones' Greek Exercises*, or its equivalent. (A knowledge of Greek accentuation will be required.)

10. A prize of twenty dollars to a member of the Scientific Classes for improvement in Drawing, and for general good conduct and application.

11. Two prizes, one of twenty-five dollars and one of fifteen dollars, will be awarded to students in Biology for the

best dissected preparations illustrating the Anatomy of any animal or vegetable type studied.

II. THE HENRY REED PRIZE, founded by the Alumni of the University, for the best English Essay by a member of the Senior Class, entitles the successful competitor to one year's interest on six hundred dollars, and to a Diploma of Merit. (Essays in competition for this prize are handed to the Dean for transmission to a Committee of the Board of Trustees, by whom the prize is awarded.) Subject: (To be announced.)

III. THE SOCIETY OF THE ALUMNI PRIZES.

1. A prize for the best Latin Essay by a member of the Graduating Class. It entitles the successful competitor to one year's interest on nine hundred dollars. (The essays are handed to the Dean for transmission to a Committee of Examiners appointed by the Society.)

2. A prize for the best Original Declamation by a member of the Junior Class. It entitles the successful competitor to one year's interest on three hundred dollars.

IV. A prize, founded by HENRY LA BARRE JAYNE, of the class of 1879, for the best English Composition by a member of the Freshman Class. It entitles the successful competitor to one year's interest on two hundred dollars. Subject: *Sherman's March to the Sea.*

V. THE JOSEPH WARNER YARDLEY PRIZE, founded by the class of 1887, in memory of their class-mate, for the best Thesis in Political Economy by a member of the Senior Class. It entitles the successful competitor to one year's interest on five hundred dollars, and to an accompanying Diploma of Merit. Subject: *The Alternative of Restrictive License and Prohibition in the Legal Regulation of the Traffic in Intoxicants.*

VI. A prize, founded by D. VAN NOSTRAND, Esq., for the member of the Junior Class in Civil Engineering who attains

the highest general average of scholarship. It consists of certain technical works.

VII. A prize, founded by the PHI KAPPA SIGMA FRATERNITY in honor of their founder, Samuel Brown Wylie Mitchell, M.D., of the class of 1852, for the best work in English Composition, done during the year, by a member of the Sophomore Class. It entitles the winner to one year's interest on four hundred dollars.

All essays in competition for prizes must be handed to the Professor in charge or to the Dean, not later than May 1st, must be signed with a fictitious name, and be accompanied by a sealed envelope, on which is written the fictitious name, and in which are enclosed the writer's real name and address. No prize will be awarded unless the work done for it reaches a high standard of excellence.

## ARRANGEMENT OF SESSIONS.

The Academic year is divided into two terms of eighteen weeks each. The first term will begin in 1889 on September 23d at 10 o'clock, A.M., and end on January 31st, at 5 o'clock, P.M. The second term will begin on February 3d at 10 o'clock and end with commencement on June 4th.

## EXAMINATIONS.

Examinations are held at the end of each term. Students who attain a certain standing are classed as "Distinguished;" those whose term-averages show them to be deficient in any of their studies are conditionally attached to their class until the deficiency has been fully made up. For persistent neglect of study, irregularity of attendance, or inability to keep up with the class, students are dropped from the rolls.

## COLLEGE GUARDIANSHIP.

Students not residing at their own homes are assigned each to some member of the Faculty for personal care and oversight. Other students are so assigned by classes or sections, the member of the Faculty in this case being known as the Class (or Section) Officer.

## DEGREE.

The Degree of Bachelor of Science (B.S.) is given on graduation to students who have completed the full course in Natural History.

## SPECIAL CERTIFICATE.

The student who has completed the two years' course preparatory to Medicine, and has passed satisfactory examinations, is granted a special certificate which admits him to the Medical School without examination, and enables him to pursue a Medical Course somewhat different from that laid down in the catalogue of that department, since he may pass his examination in certain second year studies at the end of the first year and omit entirely other branches prescribed for the first year.

## FEES.

The tuition fee in the College Department is one hundred and fifty dollars a year. In addition, a fee of five dollars is charged by the Department of Physical Culture. The annual fees for Partial Courses are as follows: For each course of one hour of instruction per week, fifteen dollars; of two hours per week, twenty-five dollars; of six hours per week, fifty dollars. But in no case shall the tuition fee be less than fifteen dollars, or more than one hundred and fifty dollars a year. A deposit of ten dollars is required in each laboratory to cover breakage. Any balance is returned.

The annual tuition fees are payable to the treasurer of the University in two instalments on October 1st and February 1st. A graduation fee of twenty dollars is charged to each candidate for the Baccalaureate Degree, and of ten dollars to each candidate for the Master's Degree. The fee for each certificate is ten dollars.

# GRADUATE INSTRUCTION.

## DEPARTMENT OF PHILOSOPHY.

Students in the Department of Philosophy, who have selected Botany or Zoology as the main subject in their course for the degree of Doctor of Philosophy, and who have had the requisite training, will, on entering, begin original investigation for the required graduation thesis. If not sufficiently prepared for this work, or if Botany or Zoology, or both, have been selected as subordinate studies, the students are advised to take such courses in Biology as may be deemed necessary. Instruction of advanced students and of those engaged in special work is given by special lectures and by laboratory exercises under the personal direction of the Professors. The conditions of entrance, fees, examinations and degrees are set forth in the announcements issued by the Department of Philosophy.

# THE BUILDINGS AND EQUIPMENT.

LABORATORY OF GENERAL BIOLOGY, FROM THE EAST.

# THE LABORATORY.

Previous to 1884 there was no laboratory building in Philadelphia especially devoted to instruction and research in Biology. Some good teaching of an elementary character had been done in the neighboring Schools and Colleges, but advanced work and investigation had always been carried on by individuals, engaged for the most part in other pursuits, with the aid of the collections and libraries of the Academy of Natural Sciences, and of the Entomological and Philosophical Societies. Even in the University both the elementary and advanced instruction were unsatisfactory. The chairs of Zoology and Botany were ably filled, but laboratory facilities were few—several small rooms furnished with an insufficient supply of microscopes and appliances,—and the urgent demands for the development of other important departments of scientific instruction prevented the proper recognition of the educational value of the Natural Sciences when unapplied. With the advent of a new administration in 1881, and with a rapid improvement in the financial condition of the University, it became a settled purpose to develop this branch of graduate and undergraduate work. Early in 1882 a systematic study of the whole question was begun. The courses of instruction offered here and abroad were critically compared, and the best methods of work were collected by several years spent in the leading laboratories of England and the Continent. In 1884 the present Laboratory Building was completed and the Faculty of Biology created. The Laboratory Building is a plain, rectangular, three-story structure, situated on Pine Street near 37th, in

the forty-one acres now owned by the University in West Philadelphia, fifteen minutes by horse cars from Broad and Market Streets, and ten minutes from Powelton Avenue Railroad Station. The South Street station of the Pennsylvania Railroad is situated at the eastern limit of the University property. The building has a north frontage on Pine Street of eighty-two feet and a depth of forty-seven feet. While no attempt has been made to secure architectural beauty, it is neatly built of pressed brick with brown stone trimmings and attractively finished inside. It is heated throughout by steam and lighted by one hundred and fifty windows. Each of the twenty-eight laboratories it contains is supplied with water and gas, the latter both from chandeliers on the ceiling and from outlets on the working tables. Particular attention has been given to the sanitary arrangement. In the basement, in addition to rooms for the janitor, space for the boiler, etc., are two rooms for use in Photography, one carefully fitted up as a dark room, the other set aside for washing and toning large plates or prints; a large workshop and a hall, 50 by 20 feet, for the sorting and storage of laboratory materials. The floors of these rooms are of cement to permit of thorough and effective cleaning. The rooms on the first floor arranged around the central hall comprise a lecture room, museum and the laboratories. The lecture room will seat 150 students, and is well fitted with desks and blackboards and an oxy-hydrogen lantern supplied with gas from tanks in the basement. On the walls is arranged a series of exquisite photographs of plants used in medicine. Connected with the lecture room is a Zoological Museum containing principally, typical forms for instruction purposes. These are contained in handsome cases, some of which are of the pattern introduced and used in the United States National Museum. On the other side of the hall, in the west end of the building, on the north is the Histo

logical Laboratory, which will accommodate 25 students, and on the south, communicating with it, the Laboratory of Physiological Botany, which is now being carefully refitted with the best furniture and apparatus for the most effective study of this important branch. A small green-house, 20 x 30 feet, is connected with this laboratory and stocked with choice representative plants. On the first floor is also the clerk's office, connected by electric bells and speaking tubes with the different laboratories and by telephone with the office of the Dean. The second floor is occupied by the four private laboratories of the Professors of Botany, Zoology and Embryology, the research laboratories of Botany and of Experimental Psychology, the Herbarium, Library and special rooms for advanced students. The third floor contains nine rooms, the laboratory of General Biology, 80 feet long by 20 feet deep, occupying the entire northern half. On the south side of the building at the east are the private room and laboratory of the Professor of General Biology. The Zootomical laboratory, assistants' room and the private laboratory of the Professor of Vertebrate Morphology lie in the centre of the south side, while the photographic studios and general chemical stock room occupy the southwest corner.

# THE MUSEUM.

This feature of the Biological Department has been properly regarded as one of the greatest importance, and an effort has been made to make it a practical adjunct to the teaching facilities of the institution. A short account of what our Museum now is, and what it is intended that it shall become, may not be out of place.

Through the liberality of Professor Jayne the Museum possesses a fine series of skeletons of vertebrates, in addition to such as properly belong to a collection which were originally designed to illustrate comparative anatomy, and which were formerly in the Medical Museum of the University. It also contains a series of wet preparations or dissections of the vertebrates, mainly the work of the celebrated anatomist, Professor Leidy, the Director of the Department. Models in wax, papier-mache, gelatine and glass by Brendel of Berlin, Blascka of Dresden, Weisker of Leipzig, and Azoux of Paris, form a part of the collection. These are used to illustrate the lectures on anatomy, histology, embryology, special organs and zoological types. The Museum also contains specimens illustrating the groups of invertebrates and vertebrates and are available in the lectures on general zoology. These are in the form of mounted skins and alcoholics. A series of invertebrate fossils are also a part of the collection. A large collection of Coleoptera and other insects, which admirably serve to illustrate the methods of the taxonomist, has been deposited in the laboratory building. A series of alcoholic specimens of the marine

invertebrates of the Bay of Naples, from the celebrated station established there by Dohrn, and prepared by the well-known Salvatore Lo Bianco, was added to the collections about a year since. This series has been supplemented by important additions from the eastern coast of the United States, collected by the Director, Dr. Leidy. A fine series of the marine invertebrates of the West Indian region was also secured and added to the Museum by Professor Dolley during his collecting tour in the Bahama Islands a year ago.

Besides the collections named above, the department possesses about fifteen hundred lantern slides, and about one thousand diagrams and charts, which are available for the purpose of illustrating the lectures of the professors in their several specialties. The fine series of zoological charts by Leuckart and Nitsche, Leipzig, and the series of botanical charts by Kny, form a part of the collection, the remainder being principally the work of the professors. The collections in botany and those in embryology and histology are referred to under the head of those courses and need not be mentioned in this connection.

From this recapitulation it may be gathered that the Museum of the Department is at present mainly subservient to the regular work of teaching. This, however, is not the ultimate purpose of the Museum, and the Faculty of the Department hope that it may not be long before it will have generous friends, who will provide it with the means to place it in the very front rank of collections designed to illustrate not merely the types of the organisms of the natural system, but also their genetic relations to each other and their relations to their physical surroundings, etc. A collection arranged and displayed with the addition of complete sets of dissections and models, supplemented by large series of macroscopic and microscopic sections, may be made so valuable as to become practically unique and

of the very first importance in the study of the laws of life in their widest sense. The study of morphology, or of structure, and what it signifies, in the light of physiology, classification and the doctrine of natural selection has undergone a complete revolution within about the last two decades. The study of morphology no longer implies that differences of structure shall serve merely the caprices of systematic biological writers, or those who, upon the basis of a more or less incomplete study of a natural group of forms, make a new systematic arrangement or classification of the latter the end and aim of their work. The business of the morphologist of to-day is no longer the mere cataloguing of species and varieties, and hunting for marks by which one species can be distinguished from another, not forgetting, when he finds a new one, to add an abbreviation of his own name to that of the Latin binominal by which he has seen fit to designate his discovery. While many of the older American biologists have felt that the new morphological discipline was to be frowned upon and discouraged as too narrow and special, others, who have more thoroughly understood its aims, know that the only protest of the present biological renascense, which took its rise in Johannes Müller's laboratory, forty years ago, is directed against the superficialities and trivialities of biological dilettantism. None of the really valuable work of the former generation of systematists, anatomists and physiologists, which is based upon a comprehensive study of groups, can be ignored, and it is simply to keep up to the highest ideas of the leaders of the movements of forty years ago and their successors which is the real aim of the present generation of workers.

To achieve the highest results in morphological study the most extensive comparisons are necessary, involving the examination of a great amount of detail. The recently published

LAKE LIBRARY

magnificently monographic work of Max Fürbringer, on the class of birds, shows plainly enough what will be exacted of the systematists of the present and the future. Especially in the vertebrated series has this become apparent on account of the complexity of the correlations of structure and function which are involved. Nor is it less true of those groups of similar forms which have undergone a complicated series of adaptive modifications, as a result of which the interpretation of their genetic and, consequently, their systematic relations rests upon the successful deciphering of their morphology in the broadest sense of the term. It is not reserved for the embryologist or histologist alone to utter the final word as to what structure signifies in reference to questions arising in classification, any more than that it is to be assumed that the investigator who deals with the anatomy of the adolescent forms of life can finally formulate the explanations or assign just reasons for a given arrangement of natural types. There is a growing conviction that many features which are developed in embryonic life are themselves adaptive, and that many such adaptions have arisen within a comparatively recent period in the history of the evolution of organic species. Instances might be cited if this were the proper place for their discussion. Embryology and microscopic anatomy are parts of one great morphological discipline, which is itself only a part of the still more comprehensive subject of biology. The proper function of a biological school is to avail itself of every known means to develop the spirit of scientific investigation amongst its pupils and teachers. To this end a museum is an all-important help in fostering the best kind of teaching, as well as constantly adding to the means through which new research may be conducted.

The continued growth of the Museum is assured through the generosity of its many friends. Fresh materials, which are

given to the department through the generosity of the Zoological Society of Philadelphia, frequently representing rare forms which have failed to withstand the rigors of this climate and the necessary restrictions of a life of captivity, often furnish the students of zootomy rare opportunities for study and comparison. This will also afford an opportunity to gradually complete suites of preparations representing analogous organs of various types, which are arranged in such a way as to show the modifications which are correlative to modification of other parts. The brain and nervous system are to form the basis, for example, of a series of preparations, which will be of the greatest significance to the anatomist and physiologist, in that its purpose is to show the modifications consequent upon new adaptations of the apparatus presiding over motion and sensation. This series will furthermore be supplemented by sections illustrating the comparative histology of the nervous system of the animal kingdom. In this way it is proposed, in the course of years, to illustrate in a completely unique manner the whole subject of comparative morphology. The study of morphology thus illustrated and conducted will become constructive or synthetic, and results of the most transcendent scientific importance may be safely looked for from an institution thus equipped. The collection is not to be simply representative of natural history in the old sense, but will include that phase of museum development in which there is represented the vastly more important morphological and physiological side. By developing our Museum in this manner we shall also avoid rivalry with the very large and valuable collections representing systematic zoology and botany possessed by the Academy of Natural Sciences of this city. The two collections should supplement each other, but in no sense become rivals; to make them rivals would be not only a waste of money, but also of valuable effort.

The gradual acquisition of large suites of preparations, put into desirable shape for permanent museum display and lecture demonstrations, forming the minor synthetic series of the great synthetic museum plan here contemplated, so as to illustrate on the broadest possible basis the principles of morphological science, is the purpose of our Museum. A collection of this kind would in twenty years place the University of Pennsylvania in possession of collections which could not be excelled on this continent.

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## THE HERBARIUM.

An herbarium is a necessity in the study of systematic botany. The larger it is, the better. In this respect the Biological School is fortunately well equipped. Through the generosity of the collector, Mr. Isaac Burk, it possesses a singularly complete representation of the Flora of the vicinity of Philadelphia. To secure this, has been the work of years, and the donor is still engaged in adding to it such novelties as can be found. For study of the plants of this region, therefore, the institution is amply provided. Mr. Burk's collection also includes many species from other localities. In all, it contains not far from six thousand specimens.

In addition to this series, Professor Rothrock has deposited his very extensive herbarium in the Biological Building, where it can be used for study by all properly accredited students of botany. It embraces about fifty thousand specimens.

This collection is very rich in the general Flora of North America (including Mexico), containing many specimens from the earlier Government expeditions and full suites of the collections made by Perry, Hall, Harbour, Vasey, Bolander, Palmer,

Lemmon, Canby, Ward, Pringle, Bibb, Wolfe, Curtis, Reverchon, Rothrock and others. It has also a full representation of the plants obtained by the late Horace Mann, Jr., in the Sandwich Islands. There are, besides, large numbers of specimens by Wright, from Cuba, and many species from the herbarium of John Stuart Mill and the DeCandolles, and Müller in Australia.

The herbarium also contains a large proportion of our native ferns, mosses and lichens, and over two thousand species of fungi, all of which have been carefully determined by our most distinguished authorities.

The botanic library of Professor Rothrock is in the building and contains the volumes most needed for systematic work. It is practically complete in American botanical literature.

It is proposed in the near future to begin a Museum of Economic Botany, for which considerable material is already on hand.

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## THE GREEN-HOUSE.

The Green-house which has recently been built for the convenience of the Biological School, serves a double purpose. In it is developed the necessary microscopic animal life for the course in Biology as well as the plants for the several courses in Botany.

The plants have been largely selected for their special fitness to illustrate either points in Morphology, Anatomy and Physiology, or Systematic and Economic Botany.

There are about 600 flowering plants now in the Green-house; these are grouped in 75 natural orders and 152 different genera.

IN THE GREENHOUSE.

# THE BOTANIC GARDEN.

Although the college campus has been carefully planted with trees and shrubs for educational purposes, and it is hoped that with time the entire University property may be made one large garden, nevertheless a certain definite piece of ground has been long needed, on which the rarer and often apparently uninteresting plants might be safely cared for, and where experimental work of an agricultural nature might be undertaken.

A Botanic Garden of this kind has been begun immediately adjacent to the Biological Building. It is proposed that this garden shall not only afford ample material for general classroom work, but that it shall contain representatives of all the more important orders of plants that will endure our winters.

Already a number of valuable trees have been set out, and the friends of the school are daily increasing the size and variety of the collection.

It is also intended that each student who desires it shall have a plot of ground assigned him, in which he will be encouraged to undertake investigations into the life histories of such plants as may be given him for study. In a word, it is hoped to make this Garden useful in training observers for more extended field work, and to utilize it also in the solution of the various problems which occur in plant life, where the observer must have the plants under his own eyes or those of reliable assistants.

# THE LIBRARY.

Through the liberality of several friends of the School of Biology, a very valuable reference library has been accumulated, consisting of about two thousand volumes. This includes the more important periodicals devoted to botany, zoology, physiology, histology, embryology and microscopy, the current numbers of over forty of which are kept on file. The Bulletins, Transactions and Proceedings of the Scientific Societies of America, and the classical monographs and memoirs of modern biologists, have been and are being constantly added.

Pamphlets are assorted and filed until of sufficient number, when they are bound under the title of their appropriate department of biological inquiry. The library is arranged alphabetically, has a complete card catalogue, and is available at all times to both teachers and students, on condition that all books shall be in the building during working hours. One of the assistants is placed in charge of the library, and sees that each laboratory is kept supplied with the chief books of reference relating to the work on hand; these are placed in small book cases in the several laboratories, for the use of students during and between their hours of practical work. It is also the duty of this assistant to look up for the different instructors the literature of subjects under investigation, and to furnish them with all the data afforded by the library. Students are also directed how to work up the bibliography of a chosen subject, the assistant giving them practical training in the use of the various records of scientific discovery.

The University Library proper, with its 60,000 bound volumes and like number of unbound volumes and pamphlets, is open to matriculates of this School. Special alcoves and rooms for study, in the new fire-proof structure, will be available to the Faculty for quiet consultation of its treasures. Besides the above, the various scientific libraries of Philadelphia are open under proper restrictions to those connected with the School of Biology.

This privilege is one of most uncommon value, as is shown by the fact that the library of the Academy of Natural Sciences has but one superior of its kind, viz., that of the Imperial Academy of St. Petersburg, Russia.

The other scientific institutions of the city have libraries with few equals in America, while with collections of general literature the city is uncommonly well supplied.

There are hundreds of persons who have in their possession odd numbers of scientific journals, reports of scientific societies and technical books; a kind of literature for which they have perhaps no room or particular use. To such persons the Library Committee of this School would say, that it is the contribution of just such collections that enable them to fill up back sets of journals or reports, to complete collections of the writings of American naturalists, and to add occasional rare volumes to the library.

# THE JOURNAL CLUB.

The object of the Journal Club is the promotion of high scholarship in biological studies through a better acquaintance with current biological literature, and that of allied sciences, to be secured by means of careful reviews and critiques, presented at regular meetings by its members.

All students or graduates interested in biological studies, as well as members of the biological faculty, instructors and assistants in the same, are eligible to membership. The meetings are characterized by perfect freedom of discussion and lack of formality. While there are each time a certain number of reviews arranged for and announced previous to the meeting, each member is expected to communicate any interesting discovery of which he may have read. Individual experiences respecting matters of geographical distribution, habits or structural phenomena, are brought out, and the student learns how to present in a clear forcible style his observations, or those of other persons, with criticisms based upon collateral reading, private investigation or consultation with other authorities. While attendance upon the meetings of the Journal Club is in no wise compulsory, students find it much to their advantage that a special hour is assigned to it in the regular roster.

# PHOTOGRAPHIC FACILITIES.

Early in the history of this School the necessity was felt not only for a thoroughly equipped photographic studio, but for a trained professional photographer, who should be constantly on hand to photograph dissections, anomalies and living specimens, and to prepare lantern slides for lectures as they were required. To meet the expense necessary to the attainment of this convenience, it was decided to offer to do the photographic work of the entire University, and to prepare lectures and other scientific illustrations for individuals and neighboring institutions. As a result, numerous pieces of improved apparatus, valuable documents, archæological treasures, etc., are sent in by the investigators of the city. Patients exhibiting deformities or peculiar pathological conditions, are continually being brought from the neighboring hospitals and by physicians in private practice; the conditions being such as to obviate any reason for hesitancy on the part of the patient, perfect privacy being secured, as the photographer is held strictly responsible for the care of all negatives. The demand for lantern slides has steadily increased, and the attempt to maintain a skilfully managed photographic studio throughout the college year has become a perfect success.

Within a few years the general introduction of dry plates into photography has opened new vistas in all directions. The importance and the possibilities of the photographic art in science we can as yet barely conjecture. Its field is widening

rapidly, and its claims for recognition as a branch of study in all advanced schools are daily becoming more urgent.

The well-known work of Mr. Muybridge in developing negatives of running animals was mainly done in the Biological Building. The rooms at his disposal for that work have been further increased, and opportunity is given to all students who may desire it, to become expert photographers in general outside work and in copying.

It is further intended that the relation of the Camera to the Microscope shall be more fully brought out, and hereafter photo-micrographic work will become a feature in the regular course of instruction to all advanced students of this department.

So soon as the demand will warrant it, a full course of instruction, embracing all lines of photographic work, will be offered.

The photographer is prepared to furnish copies of illustrations and to prepare lantern slides at reasonable rates. We have in hand about three thousand negatives taken from nature and from standard works, and representing all branches of science. A copy of the catalogue of these illustrations will be furnished on application. Address, Photographer to the University of Pennsylvania, School of Biology, Thirty-seventh and Pine Streets, Philadelphia, Pa.

# THE METHODS OF INSTRUCTION.

EAST END OF ZOOTOMICAL LABORATORY.

# THE INSTRUCTION IN BIOLOGY.

## PRELIMINARY CONSIDERATIONS.

Under the able advocacy of such men as Sir James Paget, Sir Charles Lyell, Sir Richard Owen, Dr. Carpenter, Dr. Youmans, Canon Kingsley, Thomas H. Huxley, Andrew Wilson Jeffereys Parker, C. O. Whitman and others, the claim of biology to rank high among the more efficient means of disciplining the mind has been sustained beyond cavil. It is unnecessary, therefore, to assume the position of an apologist for a system of mental training already possessing the support of such eminent authorities in scientific matters as those noted above. The fact that the art of observation is the beginning of all true science, or regulated common sense, as Huxley puts it, renders any course of training which shall develop keen mental perception, eye memory and the habit of readily concentrating attention, of the greatest possible value as a preliminary to the study of those professions which especially require the development of these faculties. Thus, as a course preparatory to the various branches of medicine, biology has from the first been held in favor, and the time is rapidly approaching when no medical school of repute will matriculate students lacking this training.

Prof. Huxley, in one of his addresses, refers to this subject in the following words: "To all those who are studying biological science with a view to their own edification merely, or with the intention of becoming zoologists or botanists; to all those who intend to pursue physiology, and especially to those who propose to employ the working years of their lives in the prac-

tice of medicine, I say there is no training so fitted, or which may be of such important service to them, as the thorough discipline of practical biological work. Moreover, all the more or less acute lay or clerical persons who venture into the regions of biological controversy would profit by a little sound, thorough, practical elementary instruction in biology."

Biological training furnishes the only appropriate foundation upon which teachers of natural history subjects may base their specialized professional studies. First hand knowledge is the only reliable equipment for a teacher of science; to teach which one must have a laboratory, to acquire which one must go to a laboratory.

The method of imparting knowledge first employed by naturalists and brought into prominence in this country by Louis Agassiz and Asa Gray, and ordinarily spoken of as "the laboratory method," has within late years been adopted in the study of widely varying fields of inquiry, such as modern and ancient languages, history and metaphysics. The teachers of these and allied subjects are wont to refer to this as "the natural method;" but whatever name be applied to it, it is but an application of the system employed and advocated for years by naturalists, in reality an advanced system of object teaching.

Bentham long since pointed out the necessity of American naturalists studying all faunas and all floras, if they would rightly understand their own, since the United States has within its confines several biological regions and few endemic characters in respect to biology. Therefore, no American institution that lacks extensive zoological and botanical collections, can offer adequate facilities for the training of professional naturalists. The advantages of Philadelphia from this standpoint are well worthy of consideration. The rich store of skeletons, stuffed and preserved animals, dissections and casts, in the halls

of the Academy of Natural Sciences, the University, the Wagner Free Institute of Science and the College of Physicians, as well as many valuable private collections, leave little to be asked for by the systematist. The ample opportunities for research in botanical subjects afforded by the herbaria of the Academy of Natural Sciences and the University, by the green-houses of this department and the Horticultural Hall at Fairmount Park, and at the celebrated Bartram Gardens, place Philadelphia in a position, when taken with the botanically rich neighborhood, to maintain her pre-eminence as the headquarters of a region that has given to this county more botanists of note than all other counties and States combined. Living animals and abundance of interesting specimens for dissection are furnished by the constantly changing collections of the Zoological Gardens and the fresh, salt and brackish waters of the vicinity.

To recapitulate: what with its rich collections, its naturally favorable surroundings and the unexcelled biological libraries of the Academy of Natural Sciences and the American Philosophical Society, Philadelphia is better suited for the pursuit of biological study than almost any other American city.

Philadelphia, the first of American cities to take organized steps for the study of the natural sciences, has steadily maintained her position as a centre of original research, and in certain lines her collections, libraries and educational facilities in this department of knowledge stand unrivalled.

The association of people holding certain scientific interests in common, and the collection and exhibition by them of natural history specimens, however, fell short of just what was required by the public, the demand being for a kindred institution devoted exclusively to systematic instruction in biology, in charge of a corps of thoroughly trained professional naturalists. This demand has now been supplied by the University of Pennsyl-

vania in the organization of the School of Biology. The doors of this school are open without distinction to both sexes, and there is now no reason why our private and public schools should not require and secure teachers with as thorough training in the facts and methods of the life sciences, as is looked for in language, mathematics or history.

As a general culture course, in connection with the so-called liberal arts courses of the colleges, biology is now taking a rank of the greatest importance. A knowledge of the characteristics of living matter and of the laws governing the existence and behavior of plants and animals is related to every other branch of purely physical inquiry and furnishes a foundation for the researches of the metaphysician.

The value of method, of a definite notion of the object in view, and of the means by which it is to be attained, is recognized by all, and in no line of training is this more surely acquired than in the study of the classified information of the biological sciences.

"As a mere matter of mental gymnastics," says Thistleton Dyer, "taxonomic science will hold its own with any pursuit," and Mill goes on to show that "the proper arrangement of a code of laws depends on the same scientific conditions as the classifications in natural history; nor could there," he adds, "be a better preparatory discipline for that important function than the principles of natural arrangement, not only in the abstract, but in their actual application to the class of phenomena for which they were first elaborated and which are still the best school for learning their use." The habit of repeated verification begets a mode of thought that is opposed to *a priori* conclusions and which moves by logical stages, and this methodical rigorous habit is of equal value to all men who would think rightly. The fact that this mental habit is gained by the satis-

fying of a desire, natural to all, to understand the problems of every-day existence and the principles that govern them, gives to biology a peculiar vantage ground over those studies which awaken no natural desire for information, inasmuch as the subjects considered offer a natural incentive to study, whereas knowledge gained by compulsion, or that lacks inherent interest has but slight hold on the mind.

The general atmosphere of a successful laboratory, one which aims not only to train, but to create and direct investigations, should be favorable to concentration of thought. It should have the quiet of a great library, it should surround its occupants with influences tending to animate their latent native energies, to inspire a love and encourage an enthusiastic zeal for independent work.

Appreciation of the fact that successful teaching can exist only in connection with perfect discipline, has led to a determination on the part of the faculty to keep the laboratories clean and quiet; loud talking and boisterous behavior being no more tolerated than in a public reading-room. The system of government is a simple one, consisting only of the accepted rules of polite conduct, firmly insisted upon. Constant employment is provided and the willing attention of students secured by the personal character of the instruction. The absence of any system of rewards or demerits, or other methods of grading, must not be misinterpreted to mean laxity in oversight. The faculty retain and exercise without hesitation the right to dispense with the company of mere idlers or aimless *dilletanti*, whose presence would tend to detract from the habits of thoroughness which it is desired to maintain.

The individuality of students should be fostered by the abolition of all marking or grading systems, or anything approaching the old class system, in so far as possible. All nature

condemns uniformity, natural attributes need guiding, not repressing, and the successful laboratory instructor seeks to develop common sense, a possession which nothing can replace, not even genius; he aims to stimulate originality in place of acquisition by rote or rule of thumb, and he accomplishes this most surely by an individual personal interest in each student. By such methods a taste for investigation is developed, which will hold good for all subjects having intrinsic interest, and the student is trained in methods of study almost unconsciously.

The possession of a cultivated taste for some special line of scientific study has undoubtedly saved and will yet save many business and professional men from shattered nerves and financial failure, and has been a source of life-long pleasure to many so amply provided for in other respects that an incentive to mental activity was their only want. Again, as Mr. Hamerton has well said, "to have one favorite study and live in it with happy familiarity and to cultivate every portion of it diligently and lovingly, as a small yoeman proprietor cultivates his land, this, as to study at least, is the most enviable intellectual life;" "and if," adds Dr. Andrew Wilson, "a study should be sought for, which shall most pleasantly aid in the cultivation of the inner life, it will assuredly be found more readily within the domain of biology than in any other department of human knowledge."

# THE COURSE IN GENERAL BIOLOGY.

This Course embraces the study of the structure, functions and life history of a selected number of plants and animals. It is based upon the plan which has worked so successfully in the colleges of Great Britain and Europe, and to which is largely to be attributed the steady advance made in biological science during the past fifty years, a plan instituted by Professors Huxley, Lancaster, Bower, etc.

The instruction is in the form of familiar lectures, accompanied by practical personal oversight in the laboratory. The pupil studies living and preserved specimens, pictorial delineations, and written descriptions, which include not only a consideration of the life history, from an anatomical and physiological standpoint, of a representative series of plants and animals, but a thorough training in the delicate manipulation requisite to reliable biological investigation.

Thus the Course tends to engender habits of close observation, quick perception and neat-handedness, at the same time furnishing the student a fund of essential information concerning the material world; while of greater importance than the useful facts themselves are the training and strength the mind receives in mastering these facts and the principles which govern them.

The power of aggregating facts of a kindred nature, of assigning them to one common cause, or of proving them to be the manifestation of some general method of natural procedure

is fostered by the arrangement of the Course, which is according to the historical method, from the simple to the complex.

The student is first taught to see accurately, and is then shown how to study types of plants and animals which gradually advance in rank and value. He is thus brought face to face with the great principle of specialization of function, and is given an index to the natural order of living things.

The idea upon which this study of types is based, is well expressed by W. P. Johnston, President of Tulane University,* as follows:

"I have a belief that one of the best ways to master a vast subject is to take one part of it and learn to understand it intelligently in its obvious bearings, and then another part, and then still another, and then if we shall put these known parts side by side in our minds and compare them together, their resemblances and their differences, their accidents and their essentials, we may come to discover the underlying principle which gives unity to the whole subject."

The Course in General Biology stands complete in itself, and affords an opportunity to college students in literary, classical or scientific courses to obtain an intelligent knowledge of the methods and principles guiding the naturalist, and an outline of the more important facts of life science. It meets the requirements of many who are not college matriculates, but who desire such training as will enable them to satisfy an instinctive love of nature, by utilizing to the best advantage the leisure moments of life. There are many grown men and women who regret the necessity that deprived them in their youth of the training necessary to an intelligent interpretation of the phenomena of life, as exhibited by the myriad

* Address on Education, before the National Education Convention of 1886.

beautiful forms of land and sea. To such persons this Course is particularly advantageous, inasmuch as it covers a large field and prepares the way to advanced courses or individual study.

Although books of reference are always at hand, and in fact the more important articles bearing upon the subject of study are always brought into the laboratory, and students are taught the methods of looking up the bibliography of scientific subjects, still few text-books are used, and independence of thought is encouraged by the practice of carefully recording the results of observations and of taking numerous brief notes on the lectures. Stress is laid upon free-hand drawing, in which regular instruction is given outside the laboratory. In the delineation of a plant or animal structure in the laboratory it is treated much as an architect does an edifice; the whole structure is first drawn, then consecutive details in connection with this structure, showing the details completely, but the surrounding parts diagramatically. Diagramatic drawing is of great assistance in studying anatomy, whether of plants or animals, enabling the student to fix his attention upon one part of a series to the exclusion of the rest. A Course in ordinary and microscopic photography, under the direction of the Professor of Botany and of the Photographer to the Department, a professional worker of over forty years' experience with the most complete facilities, is open to students of the School of Biology for a small fee. The 216 hours of the college year devoted to General Biology are divided up as follows: The first 24 hours are devoted to the acquisition of careful habits of work and a thorough understanding of the methods and the apparatus employed in modern biological research.

The next 12 hours of the Laboratory Course are devoted to a practical study of the conditions and materials essential to the manifestations of life. The class then enters upon the

practical study of types. About 180 hours are occupied with the study of some eighteen or twenty characteristic examples of plant and animal life, in the order given in the appended synopsis. Whenever it is possible, properly prepared material is kept in stock, and permanent arrangements are made for the propagation or securing of about thirty types. A certain latitude is necessary in the selection of types, as it often happens that certain ones have not yet reached the stage of growth best adapted to laboratory work. Handbooks containing detailed directions for the study of typical plants and animals, have multiplied to such an extent of late that it is impossible, with justice to the student, to adopt any one as a text-book, inasmuch as in every case desirable forms are omitted, or much space given to forms that are not available away from the sea-shore or in the winter months.

It has therefore been deemed wise to select from these laboratory guides such chapters as are suited to the requirements of this particular laboratory.

By securing duplicates and having the desirable chapters removed and bound separately, students are supplied with just what is needed, and they are deprived of the temptation to anticipate the course, by the private study of types, which, from their complex character, should be approached through simpler forms. In the studies given in the following synopsis of the course, the author of the syllabus employed is named in parentheses:

STUDY.

I. Manipulations of the Microscope and its Accessories (Bausch).
II. The Composition of Living Organisms.
III. Living Matter or Protoplasm.
IV. Cells and their Contents.

V. Bacteria (Dolley).
VI. Yeast (Dolley).
VII. Protococcus (Huxley and Martin).
VIII. Amœba (Huxley and Martin, W. K. Brooks, Marshall and Hurst).
IX. Paramæcium (W. K. Brooks, Marshall and Hurst).
X. Vorticella (W. K. Brooks, Marshall and Hurst).
XI. Calcareous Sponge (W. K. Brooks).
XII. Stoneworts (Strasburger, etc.).
XIII. Hydra (Marshall and Hurst).
XIV. Starfish (W. K. Brooks).
XV. Sea Urchin (W. K. Brooks).
XVI. Earthworm (Marshall and Hurst).
XVII. Bracken Fern (Sedgewick and Wilson).
XVIII. Fresh Water Mussel (Marshall and Hurst).
XIX. Snail (Marshall and Hurst).
XX. Squid (Brooks).
XXI. Crayfish (Marshall and Hurst).
XXII. Cyclops (Brooks).
XXIII. Grasshopper (Henry Comstock).
XXIV. Cockroach (Marshall and Hurst).
XXV. Tunicate (Dolley).
XXVI. Amphioxus (Marshall and Hurst).
XXVII. The Skate (Foster).
XXVIII. The Herring (Ryder and Dolley).
XXIX. The Frog.
XXX. The Lizard.
XXXI. The Chicken (Marshall and Hurst).

Students are required once a month to hand in their notebooks and drawings for inspection.

Notes should be copied carefully into notebooks of uniform size. Drawings should be made on drawing tablets, and the finished work, enclosed in a large envelope, to accompany the notebooks. Rough or incomplete sketches, while of passing value to the student, are not to be submitted for criticism. Each student will be required, before coming up for final examination, to hand in, together with his notes and drawings, one of the following:

*a.* A wax, plaster or papier-maché model, made by the ordinary methods, illustrating some particular structural characteristic of a plant or animal.

*b.* A model, made by Born's method, of some microscopic structure.

*c.* A preparation showing the distribution and arrangement of vessels, canals or sinuses, made by Hyrtl's corrosion method.

*d.* A set of twenty-five slides, illustrating the microscopic anatomy of some typical plant or animal, with accompanying description.

*e.* A series of five diagrams, 24 x 30, in colors or india-ink, illustrating the structure or life history of any form studied.

*f.* A dissection, or series of dissections, preserved in alcohol, illustrating special details in the anatomy of any form studied.

*g.* Alcohol preparation of frozen sections, illustrating some special anatomical point.

*h.* A dry preparation, made according to Semper's method, of an animal, or parts of an animal, so dissected as to illustrate structural peculiarities.

*i.* A collection of specimens, dry or alcoholic, illustrating the systematic relationships of any family of plants or animals.

*j.* A thesis on some biological theme, setting forth the results of original research on the part of the author.

The idea is to secure practical evidence on the part of the students that they have become conversant with the methods taught in the Course of General Biology. Meritorious preparations will, in every case, be placed in the Museum, duly accredited, and the theses published, if showing sufficient originality.

Students whose powers of observation and comparison are to be developed, and who are taking up, perhaps for the first time, the use of delicate instruments, and seeking to acquire a thorough mastery of method, require good light, sufficient room, solid tables of suitable height, individual outfits of reagents and apparatus, optical instruments of first-class workmanship, available gas and water facilities, abundant illustrative material and accessible works of reference, all in comfortable quiet quarters, the general atmosphere of which shall be con-

ducive to an earnest, studious frame of mind. All of these advantages are afforded by the new Laboratory of General Biology. Occupying one-half and the entire north side of the upper floor of the building, students in this laboratory are free from interruption by others passing to and from other laboratories; the room is beautifully lighted from the north, heated by steam and supplied with abundance of water and gas. The arrangements and fitting are the suggestions of long experience and of careful study of the better laboratories of Europe and America. Each student is provided with a private compartment, in which can be kept under lock and key books, reagents, instruments, etc.

The following is a list of apparatus furnished each student, and for which he is held responsible, allowance being made for all reasonable wear and tear and the use of chemicals:

APPARATUS.

1 Compound Microscope (Zeiss, Reichert, Hartnack, Leitz or Zentmayer).
2 Eye-pieces, Camera lucida, and Eye-piece micrometer.
1 Dissecting microscope (Rothrock's pattern, Zentmayer, maker, with two lenses).
1 Watch-makers' glass.
1 Life slide.
1 Moist chamber for growing moulds, etc.
1 Bunsen burner and tube.
1 Iron tripod.
1 Copper evaporating dish.
6 Test tubes.
6 Florence flasks.
2 Beakers.
3 Covered glass dishes.
1 Dissecting pan and pad.
1 Cushion.
6 Filter papers.
Absorbent cotton.
Assorted glass tubes.
Reagents, staining fluids.
Mounting media.
Acetic acid.
Hydrochloric acid.
Nitric acid.
Sulphuric acid.
Potassium hydrate.
Ammonia hydrate.
Fehling's fluid.
Millon's reagent.
Schultze's reagent.
Schultze's macerating fluid.
Glycerine.
Turpentine.
Alcohol (various grades).
Borax carmine.

Picro carmine.
Hæmatoxylon (Kleinberg's).
Aniline green.
Eosin.
Saffranin.
Methyl blue (Koch's formula).
Bismarck brown.
Gentian violet.
Canada balsam.
Glycerine jelly.

Besides the above, there is a large supply of miscellaneous apparatus, as well as a well-stocked chemical room attached to the laboratory, upon which to draw for articles not so frequently required. Each student is also given the exclusive use of a compartment in the large culture oven, regulated by a Cambridge thermostat, for use in studying the development of microbes and moulds, and the effects of constant and varying temperature. Improved injecting apparatus and microtomes of improved patterns are at the service of the students. Numerous aquaria, large and small, are continually available for retaining and propagating animal life, while the well-stocked green-house, under the charge of a trained assistant, furnishes abundant fresh material and opportunity for following the structure, physiology and development of such plants as are chosen as representative plants. Several hundred diagrams, illustrating all the details of the subjects taught, are supplemented by a large collection of microscopic preparations, dissections in alcohol, besides glass, wax and papier-maché, gelatine and clay models. The museum furnishes typical representative collections of the various groups studied, and these are taken in turn to the laboratory, in order that the student may base his idea of the race (a type of which he is studying) upon as large a number of constituent individuals as possible; by having them constantly subject to comparison, thus gaining definite sense images of the characteristics involved.

A PRIVATE ROOM.

# THE COURSE IN ZOOLOGY.

One lecture a week on General Zoology is given throughout the year.

In the first term the Invertebrates are studied and in the second the Vertebrates. Each group is taken up in turn, and the salient points in the anatomy, classification and life history exhibited.

The lecturer's intimate acquaintance with the subject and his long experience as a teacher render the course peculiarly fascinating and profitable.

Every effort is made to secure the best illustrative material, and the large stock of specimens and diagrams is constantly enlarged. With this course should be united the Laboratory Courses in Invertebrate and Vertebrate Morphology, although it may be taken alone.

# THE COURSES IN INVERTEBRATE MORPHOLOGY.

In the study of invertebrate animals the biologist finds himself possessed of materials both abundant and easily obtained; materials offering special advantages owing to the compactness with which they can be preserved and the facility with which they may be transported. In no other field except that of botany can the student of natural history so easily acquaint himself with the prevailing systems of nomenclature and classification: nowhere else can he review with so little trouble such numbers of specimens belonging to the same or closely related groups.

Owing to the great diversity in size and complexity exhibited by the members of the various orders of invertebrates, the student finds it necessary to employ all the delicacy of manipulation of which he is capable. His knowledge of the microscope must constantly supplement skill with the dissecting knife, while the relations of complicated or minute organs can only be understood by careful drawings at various stages of dissection. It is to the invertebrates that the student must go for the elucidation of the genesis and evolution of the complex systems of organs and tissues presented, for example, by the nervous and excretory apparatus of higher animals; since in the comparatively simple invertebrate forms he can trace the progressive steps of differentiation.

For a clear comprehension of the embryological development of higher animals, a knowledge of the adult stages of the simpler forms of life is requisite.

Comparative histology also depends upon a knowledge of invertebrate morphology for the key to its problems. Aside from the peculiar scientific importance of a familiarity with invertebrates and their special value in calling out all of a student's skill of hand and eye, in the dissection of individuals or in the comparison and determination of species, their practical bearing upon the welfare of mankind is so striking, that it is difficult to understand how students of human or veterinary medicine can be allowed to graduate without a practical laboratory knowledge of such forms as are constantly the active factors in the production of morbid conditions, affecting at times entire communities. The possibility of controlling epidemics of trichinosis, filariosis, or the spread of the various intestinal and other parasitic worms, depends entirely upon the practical study of the life histories of these parasites, and many vexatious mistakes would be avoided were physicians better trained as a rule in invertebrate zoology.

The agriculturist and horticulturist as well as the physician finds reason for a knowledge of a class of animals which includes the various pests that make havoc with their garden, field and forest crops. The special lines of study introduced into the education of every young man who proposes to rear plants and breed stock should include practical invertebrate zoology, in order that he may combat intelligently parasitic and destructive worms and insects, and foster with similar understanding those forms which bear beneficial relations to man. As countries become more populous, the necessity of economy of land and food becomes imperious, and better crops must be raised on fewer acres. As grazing lands become less, other sources of flesh-forming foods must largely substitute the meat of cattle, sheep and swine. In accordance with this, nations have usually turned first to the artificial propagation and culture of fishes, and later to that of various invertebrate forms, particularly mollusks and

crustaceans. Only within very recent years has the public appreciated the importance of calling to its aid the trained students of invertebrate zoology to suggest means of preventing the complete annihilation of American oyster-beds and to establish methods of co-operating with nature toward renewing and maintaining the supply. It would be out of place to refer at this time, in more than a cursory way, to either the scientific or economic importance of a practical knowledge of so vast a field in nature's domain, the intention being simply to indicate in a general way the relation of this line of study to others presented in the School of Biology.

The student is allowed to devote a share of his time for two years to the study of Invertebrate Morphology. Before entering upon this work he must have taken the Course in General Biology or its equivalent.

In the Elementary Course the student takes up several of the most characteristic species of each of the recognized groups; these he compares carefully with each other and with the representatives of other groups. As far as possible he is made acquainted with the structural modifications accompanying hermaphoditism, alternation of generations, dimorphism, polymorphism and heterogamy. No opportunity is neglected of supplying him with living material that study of structure and function may run hand in hand. The student is also directed to the literature of the subject, taught how to ascertain the present state of knowledge concerning it without loss of time, and is expected to pursue a course of reading collateral to the work in hand. This Course is parallel and supplementary to the lectures given by Professor Leidy, fixing by practical observation the points brought out in the lectures.

The Advanced Course in Invertebrate Morphology is open only to such students as have taken the Course in General

Biology and Professor Leidy's lectures on Zoology and the Elementary Course in Invertebrate Morphology, or their equivalents. The student here chooses for his work some particular form, and devotes himself to the investigation of such points in its structure or life history as may require elucidation. He is supplied with numerous specimens of the animal in question and of other species belonging to the same groups; he thus puts himself in the position of the monographer, who deals with taxonomic relations and the reasons therefor. The student's independence as an investigator is developed in every possible way, the Professor in charge offering in frequent consultations such suggestions as will obviate useless work, and by a critical supervision of the research as it proceeds suggests and forestalls in so far as he is able the problems that will arise and the criticisms that might be offered.

Students attending the Courses in Invertebrate Morphology will meet one evening each week at the house of the Professor, to read and discuss in an informal way the subjects undergoing investigation in the laboratory.

# THE COURSES IN VERTEBRATE MORPHOLOGY.

The Elementary Course in Vertebrate Morphology is closely associated with the Lectures in Zoology and, like the course in Invertebrate Morphology which it follows, explains in a practical way the leading points thus presented, and is therefore considered as the laboratory part of that instruction. The purpose of the course, broadly speaking, is to give instruction in the anatomy and classification of the higher or vertebrated animals. This is accomplished by the exact study of types of the five great classes, by comparisons with the related forms and a careful review of some small group to give practice in recognizing characters used to distinguish one animal from another. The first type considered is the little fish called the Lancelet, or Amphioxus, a primitive, though probably degraded form of the back-boned animals. The simple structure of many of the organs which in higher types have undergone complex development renders it a valuable subject for introductory study, and its peculiarities in other respects, for example, in the respiratory apparatus, show it to be an important connecting link with some invertebrate forms already studied. The student prepares transverse sections through the most important regions of the body and examines complete sets of preparations furnished in the laboratory. The reconstruction of the animal from these is aided by accurate wax models and diagrams. The study of this primitive fish prepares the way for the consideration of the fishes proper. After the dissection of the lamprey, the dog fish, or skate, furnishes opportunity for the study of a perfect carti-

laginous skeleton, a lowly organized brain and of vascular and urogenital organs highly important from a developmental standpoint. The consideration of the bony fishes is introduced by the dissection of a perch or cod, and the heterogeneous group of the Ganoids is studied by very complete preparations and mounted skeletons. These forms are compared with the lung fishes which lead to the Amphibia.

The type chosen to illustrate this class is changed from year to year, but whichever one is chosen, examples of the other three orders are also studied. The advanced structure of many of the organs is compared with those forms already mentioned, and the points which are of value, as lying in the line of development from the lowest to the highest, are kept sharply in view and separate from characters merely adaptive or peculiar to this class. The anatomy of the terrapin forms the basis of work on reptiles ; the alligators, lizards and snakes being afterward taken up. Still more advanced modifications in all organs are seen in this class, and changes of structure to coincide with life habits. The birds are studied by dissecting the common fowl, and then other species are reviewed to show more particularly differences in arrangement of feathers and scales, and the anatomical peculiarities in the wings and legs. The classification based on the structure of the skull is carefully pointed out, as well as the external characters used by ornithologists in systematic work. Several mammals, showing divergent lines of ascent, are employed to illustrate the highest class. When students have completed this course they have gained not only an exact knowledge of the structure of some representative form, but possessed a comprehensive view of Anatomy from the comparative side. They have seen the skin naked in the lancelet and amphibia, clothed with scales in the fishes and reptiles, with feathers in the birds and with hair in the mammals.

They have traced a primitive cartilaginous cranium as it becomes gradually replaced and obscured by a bony brain case, and the jaw passing from a primitive form through complex arrangements back again to a simple structure. The limbs, however modified for special purposes, are found to be constructed upon a similar plan. The vascular system has been observed from a point where the heart was a pulsatile one-chambered section of the ventral blood-vessel, through its changes from two-chambered to three-chambered, and from that condition to the organ with four cavities, as found in the birds and mammals. The evolution of the aortic arches is not only a fascinating study, but solves difficulties in normal and abnormal anatomy otherwise inexplicable. In a similar manner the other organs have been subjected to critical examination.

The laboratory is fully equipped for this work, and the museum contains a good supply of illustrative materials, while for extended systematic study the collections of the Academy of Natural Sciences can be used. In the Advanced Course in Vertebrate Morphology a different plan is followed. The student is put to work upon some special subject, or to make series of preparations in comparative anatomy. His work is individual, and not in a class, and his instruction takes the form of talks rather than lectures. The material is given him, the literature is supplied, and with occasional hints how to get the best results he is left largely to himself.

# THE COURSE IN HISTOLOGY.

The instruction in histology is under the direction of the Professor of Embryology, with whose work it is most nearly cognate.

The course is made as practical as possible, and teaching is conducted in the laboratory as well as in the lecture room. The course of lectures embraces a series of eighteen, which cover as large a range of subjects as is consistent with clearness and thoroughness. The treatment is comparative as far as possible, the frog, cat, dog, ox, lamprey, pig, fish, mouse, rabbit, fly, sow-bug, oyster, etc., etc., furnishing the material. One lecture per week is given, besides which there are six hours per week of practical laboratory work, divided into three periods of two hours each. The lectures proceed concurrently with the laboratory work, and in such a relation to the latter as to illustrate the subjects under examination during the same week in the laboratory.

The course of instruction as outlined above offers nothing peculiar to distinguish it from those in vogue elsewhere, yet there are methods of instruction adopted in our laboratories which offer enough of novelty to make it desirable to enter into more explicit details in regard to them. The usual methods of teasing and maceration are resorted to by the students in familiarizing themselves with the elementary tissues and form elements, while the blood is studied from the living subject, or it is killed and fixed at once by means of corrosive sublimate and stained successively with eosin, nigrosin and hæmatoxylin, in order to differentiate by shades of coloration the several blood

elements recognized by recent histological investigators. The various tissues and organs of the vertebrate are then taken up and studied about in the order given in Schaefer's Essentials of Histology, and an effort is made during the entire course to present sections of the same organ from a number of widely different types during the same laboratory hours. This enables the student to make comparisons at once and to note differences and likenesses of structure which would otherwise escape him. For example, during a single laboratory exercise, sections of the skin of the following forms were studied: 1. Kitten, very young; 2. Kitten, more advanced; 3. Porpoise; 4. Frog, surface views of integument, injected with silver nitrate and sections. To any one familiar with the comparative histology of the skin, it will be obvious that from this series of preparations it was possible to study the development of the hairs, hair follicles, sebaceous and skin glands of the different forms, and to also see how widely the different types differ in the minute structure of the different layers, as well as the still greater variations in the proportional thickness of the two principal layers, or epidermis and corium. The student is thus made familiar with the fact that (1) the structure of the skin is essentially similar in widely different types, and that (2) all the modifications which arise are due to variations in the proportional thickness of the two principal layers and of the histological differentiation of their constituent cellular elements. This method is comparative and brings into prominence those contrasts of minute structure found in the different types, which cannot fail to be an aid in enforcing and further illustrating the teachings of the Professor of Systematic Zoology. The method is by so much also essentially a philosophical one.

In the study of sections of tissues the pupils are directed to draw from their preparations the relations of the parts. This practice is rigidly enforced, and contributes a very important discipline in histological study.

The methods of fixing, staining and embedding objects to be studied are also carefully illustrated. Facilities for these processes are afforded by the department, which is equipped with the best and most recent forms of embedding apparatus, the inventions of the faculty, while for all fixing and staining processes the student is supplied with all necessary reagents from a well-equipped chemical store-room.

The most approved modern methods of section-cutting are in use in the histological laboratory. Both paraffine and celloidin are used for embedding, or both are combined according to a method recently devised by the Professor of Embryology.

In the preparation of sections by means of the microtome, the instruments in use are mostly those of the invention of the Professor of Embryology himself, and for rapidity of operation and wonderful accuracy leave nothing to be desired. The tissues of the animals studied in the laboratory may by these means be sliced into sections at the rate of 200 per minute, and ranging in thickness from $\frac{1}{500}$th to $\frac{1}{5000}$th of a inch. New methods recently tested and introduced into the practice of the histological course, as conducted during the past year, show that it is possible to section the heads and bodies of some of the smaller mammals and birds, and to thus place upon a single slide a preparation which epitomizes almost the entire subject matter of histology within the area of a single square inch of surface. Such single preparations may be made to show all of the elementary tissues—the skin, and its appendages, bone, cartilage, teeth, lymph and blood-vessels, brain and nerves, glandular organs and organs of sense (eye, nose and internal ear, with the rods of Corti).

The laboratory is well supplied with a collection of histological material of different types, injected and not injected, as well as masses of brain tissues, spinal cord, etc., which can soon be made ready for study.

The department also possesses a fine series of illustrative microscopic preparations made by various celebrated histologists, to which the Professor of Embryology has added his own collection, which contains many unique and valuable suites of sections.

The lectures on histology are illustrated by a fine series of lantern slides, the lecture room being so arranged as to be readily and quickly darkened and the illustrations projected with the oxy-hydrogen light upon the screen behind the lecturer.

# THE COURSE IN EMBRYOLOGY.

This course, like that upon histology, is carefully and elaborately illustrated with actual materials and preparations in the laboratory, besides which a series of didactic lectures are delivered by the Professor of Embryology, designed to illustrate the principles of the science rather than to recount minute descriptions of the processes of growth and development as encountered in a single type. The same amount of time is given to this subject during the second term as is given to histology during the first term, viz.: seven hours per week.

The course in the laboratory as well as in the lecture room is conducted according to the comparative method. The lectures are illustrated by a special series of charts, diagrams and a set of wax models made by Weisker, of Leipzig. The work in the laboratory involves the study of the embryology of a number of types, mostly vertebrates. First, the ova of different forms are compared and studied by means of sections and the differences arising from the presence and absence of food yolk clearly pointed out. The growth or maturation of the ova of different forms is also compared, and the influence of the presence of food yolk in modifying the processes of development in the higher types is especially insisted upon, and carefully illustrated by a special series of diagrams and preparations.

Total cleavage is studied in the ovum of the rabbit, the frog or some mollusk; partial cleavage in the egg of the bird, and sections or surface views of whole embryos are appealed to to illustrate the points which are considered in the successive

stages which are studied during the practical work in the laboratory. Arrangements have also recently been made by which it will be possible to demonstrate the formation of the polar globules in the oyster, or to introduce into class-room work the study of the initial steps of development anterior to the phenomena of the actual segmentation of the ovum.

To aid in the study of the development of the bird the embryological laboratory is provided with an incubator of the most approved and successful form. In this way the successive stages of development are supplied from batches of eggs placed in the incubator at known times, and removed after the lapse of such periods as will give the student the desired phases of development for study. In a similar way the embryos of the common rabbit are obtained from a family of these animals kept in the laboratory for this special purpose. The student is thus made familiar with the great differences between the mammalian germ or egg and that of the bird—the two are contrasted side by side.

Besides this, the collection of illustrative material in the possession of the Professor of Embryology is very large and is constantly appealed to for reference during class work in the laboratory in the course of the year, several hundred embryos of the rat, mouse, field-mouse, rabbit, sheep, horse, dog, cat, oppossum, representing every stage from the ovum to the fully matured fœtus. A large part of this series is of very great value for teaching purposes, because the embryos are still *in utero*, which makes it possible for sections to be prepared of the embryo and all of its enveloping membranes, such sections being supplied to the members of the class so as to enable them to make permanent preparations. This large series of embryos also serves to illustrate most fully the development of the different types of placentation.

The collection of mammalian embryos above referred to is supplemented by a very extensive series representing the sparrow and the commoner birds in all stages; these in like manner afford material for the study of all the organs as well as the embryonic membranes in place, as seen in sections prepared from the entire contents of the ovum.

This collection is also specially rich in illustrative materials showing the development of fishes, arthropods, etc., some of the series in this portion of the collection being absolutely unique, as they have afforded the basis for a number of original memoirs on the embryology of fishes and arthropods.

A large collection of mounted slides embracing many entire series of embryos is also included in the material, which is used for reference and from which drawings are made by the students in the laboratory.

A very complete series of lantern slides prepared from the drawings illustrating various classical memoirs upon embryological subjects furnish a very efficient aid to the illustration of the essential principles of the subject in the course of didactic lectures.

# THE COURSE IN MAMMALIAN ANATOMY.

Instruction in Mammalian Anatomy is introduced into the School for a twofold purpose; to give every student an opportunity to learn the structure of the human body and to teach those who intend studying medicine the principles underlying anatomy and the methods employed in the dissecting room. All regular students before entering this course have passed through the course in General Biology and have done systematic work in Zoology.

The instruction is given in the second term, principally by work in the laboratory, with such general lectures as are from time to time necessary. A definite order is followed throughout and every effort is made to ensure accurate thorough work and to guard against the formation of bad habits. Nothing is taken for granted, but every point must be seen and worked out by the student. The cat is used as the subject of dissection. The course is introduced by a preliminary lecture and written exercise on the method of description of an anatomical specimen, which explains the ground to be covered in accurate representation, and serves also as a test to the student's previous knowledge. The study of the skeleton is preceded by lectures on the microscopic, macroscopic and chemical structure of bone, cartilage and connective tissue; their classifications; functions and development. The consideration of the vertebral column is begun by a careful study of a typical vertebra, and with this as a basis the differences and similarities of the vertebræ of the different regions are clearly brought out. The skull is considered as whole and its

constituent bones are observed and drawn. For this purpose abundant material is furnished in entire skulls, in specimens sawn in transverse, longitudinal and horizontal sections, in macerating skulls which the student himself disarticulates, and in large series of prepared bones. The limbs are studied with like care, special attention being given to the relations of the carpal and tarsal bones and the methods of distinguishing the metatarsal elements from one another, those of the right limb from those of the left and the hand from a foot. The student is regarded as having completed the study of the skeleton when he can unerringly pick out from a miscellaneous heap any particular bone called for and tell to which side of the body it belongs. He must know every eminence, depression, foramen and articulation of each bone, not from the books, but practically from the specimen. In addition, to the thirty or forty disarticulated skeletons and the store in the macerating jars, there are fifteen beautifully mounted skeletons of the cat and many instructive preparations of the human skeleton. After the skeleton has been finished the muscular system is taken up, first by lectures on the structure and character of muscle tissue and the peculiar methods to be adopted in laboratory study. This is followed by the dissection of muscle groups in the following order, an order which experience has shown to be most effective:—The muscles from the trunk to the anterior extremity, the muscles of the arm and of the abdominal wall, the muscles from the trunk to the posterior extremity, the muscles of the leg, of the back, neck, face and head. The larger bloodvessels and nerves are noted at this time but not carefully studied.

Constant practical examinations test the student's knowledge, such as picking out on the specimen certain definite muscles and naming others selected by the instructor, drawing in the muscles on a large skeleton painted on a blackboard, or in answering

such general questions as the following: Show the muscles in the hind limb which pass over two joints from origin to insertion. What group of muscles arise from the internal condyle of the humerus? What muscles can aid in respiration? The student obtains a knowledge of the relations of muscles to one another and to the bones by the study of series of frozen sections. Points in Physiology are constantly introduced, and attention is called to the action of muscles in cases of fracture to illustrate their functions. After the muscles and ligaments have been completed a new subject is prepared for each student, in which the arteries have been injected with colored plaster of paris. On this specimen are studied the skin, the subdermal glands and the bloodvessels and nerves of the abdominal cavity, of the hind limb, of the axilla, thorax, arm, neck and head. In the thoracic and abdominal cavities the relation of the peritoneum and pleura and the general configuration and parts of the organs only are studied at this time.

In these exercises a knowledge of the relations of the parts studied is insisted upon. This is gained by practice in cutting down and finding bloodvessels and nerves or in drawing on the blackboard skeleton. Tracing the route which a blood corpuscle could take from the heart to any given part or organ and back to the heart again, both by direct or collateral circulation, is one of the practical exercises which add interest and reality to the course. The viscera, brain, spinal cord and cranial nerves are studied upon a third specimen, and an opportunity for review and for more thorough work on the lymphatics and sense organs is offered by a fourth specimen or by work upon some form even larger than the cat. While every assistance is given to the student in this course by lecture, quiz and personal oversight in laboratory, it has become the policy not to answer questions which the student can easily find out for himself, or only after it

has been recognized that conscientious efforts have been made to reason out the information sought.

All the important works on anatomy, drawings, diagrams and models are in the laboratory, and students are encouraged to independent work and wider reading than are actually called for by the lectures. Each student has a table to himself supplied with dissecting trays, blocks, sponges and jars for the preservation of his subject. He is required to furnish only scalpels, scissors and forceps. The instruments which are only used occasionally, such as saws, bone-forceps and syringes, are kept in a case for general use.

It is not necessary to dwell on the importance to the general student of a knowledge of his own body or upon the value of such careful work upon one type to the student who intends to devote himself to more advanced work in future. It should be said, however, that if one laboratory course in Biology only can be taken that in General Biology is the one recommended. To many, however, it is not so apparent that the study of Anatomy on such a form as the cat is of any particular value as a preparation to medical study. The physician may be inclined to say that a term could better be devoted to pure human anatomy, as a knowledge of this special subject is after all the thing ultimately to be acquired, or that this course may indeed teach some things which will have to be forgotten. This is true, unless it can be clearly shown that something positive is presented which is not brought out in the ordinary instruction in Anatomy, and that nothing is taught which requires to be again unlearned, but that what is apparently foreign to the subject is of vital importance.

There are many advantages in beginning anatomical work on such a type as the cat. Its size is such as to render careful work a prime necessity, and no opportunity is presented for

large indiscriminate cutting to which the hurried student of a large form is compelled to resort to find any particular structure. The relation of the parts can be retained throughout, as the entire body can be easily preserved and handled until the dissection is complete. Again, there is an opportunity given for the careful study of many organs which are often neglected in the human body by reason of mechanical difficulties, or because it is not always easy to obtain them owing to the post mortem examinations and removal for after-study in pathological anatomy. An advantage which cannot be overestimated is the abundance of material, the possibility of having fresh subjects whenever wanted and in any number. In this connection it may be of interest to state that the animals are not secured by us alive, and as some may have supposed subjected to the cruelties of vivisection, but are obtained from a charitable institution where they have been killed without pain.

The advantages which the type presents from a scientific standpoint, apart from those which are, so to speak, material, are quite numerous. Attention need be directed to one or two only. In the human skull, by reason of the great growth of the cranium, the bones of the face and those forming the base of the skull are crowded together, and the separate bones have become united so that almost all traces of their independent origin have been lost. In the skull of the cat, however, such predominance of the mental over the animal structures does not exist, and we find the bones distinct and their characteristic points spread out for convenient study. Such difficult problems as the sphenoid and temporal bones become easily solved, and when it has been learned how their parts have been developed and the mechanical changes which have taken place, they are never forgotten. The same can be said of the study of the brain, of certain difficult muscle groups, of the sexual organs and the folds of the peritoneum.

In general anatomy the cat differs little from man. It is true that in certain regions the muscles are more complex and in others a reduction in the number can be seen; that the big toe is absent, that the brachial plexus is more extensive, and that a common iliac artery does not exist, but these differences have positive uses in cultivating attention and thought, without which the study of Anatomy is impossible.

# THE COURSE IN OSTEOLOGY.

The Course in the Comparative Osteology of the Mammalia is open only to advanced students and pre-supposes a knowledge of the classification of animals gained in the lecture room and laboratory. The instruction consists of occasional lectures, with supervision only of the practical work; for the student is regarded as competent to rely upon himself, and original observations are encouraged. As can be seen from the sketch of the Museum, the collections are peculiarly rich in osteological material, but the work is not confined to the study of the dried bones, since these, deprived of their ligaments and cartilages, may lead to false conceptions of their relations and erroneous generalizations of their probable mechanical functions. Dissections are therefore required to illustrate, among other subjects, the types of mandibular articulation, the conformation of the cartilaginous surfaces in the various forms of tibio-tarsal articulation, the relations of tendons to joints and the development of synovial cavities and the sesamoid bones. The object of the course is not merely that the student shall acquire certain facts, but that he shall constantly endeavor to interpret the facts, not that he shall know that an alisphenoid canal, a clavicle, or a third trochanter to the femur exists in certain forms, but that he shall strive to determine the agencies and conditions which have developed such structures in these types, while they fail to appear in other closely related forms. The subject is treated by two methods. In the first, beginning always with some familiar generalized type, as the dog or cat, the variations

which each bone undergoes are traced through the different groups, from Ornithorhynchus to Man. The knowledge thus gained is fixed and broadened by the second method, in which the complete skeletons of selected types of the different orders and families are carefully examined. The fossil forms are not omitted from consideration, but are studied from specimens, casts and plates, side by side with the preparations from animals now living.

Besides a great many crania and other parts of representative genera, the following series of entire mounted and unmounted skeletons of mammalia, arranged under their orders, serve to illustrate the Course in Mammalian Osteology:

Ornithorhynchus; Echidna.

Didelphys; Dasyurus; Perameles; Macropus; Phalangista; Phascolarctos; Phascolomys.

Bradypus; Choloepus; Myrmecophaga; Priodon; Tatusia; Dasypus Xenurus; Orycteropus.

Manatus; Halicore.

Globicephalus; Phocæna.

Galeopithecus; Erinaceus; Sorex; Talpa; Scalops; Centetes.

Pteropus; Vespertilio.

Sciurus; Arctomys; Castor; Myoxus; Mus; Arvicola; Fiber; Geomys; Dipus; Capromys; Erethizon; Sphingurus; Hystrix; Lagostomus; Dasyprocta; Cœlogenys; Cavia; Hydrochærus; Lepus.

Elephas; Hyrax; Tapirus; Rhinoceros; Equus; Sus; Phacochorus; Dicotyles; Llama; Camelus; Tragulus; Cervus; Camelopardalis; Bos; Ovis; Antilocapra.

Felis; Herpestes; Hyæna; Canis; Lutra; Mephitis; Meles Galictis; Taxidea; Procyon; Nasua; Cercoleptes; Ursus; Zalophus; Phoca.

Tarsius, Nycticebus; Hapale; Ateles; Mycetes; Cynocephalus; Papio; Macacus; Semnopithicus; Hylobates; Homo.

# THE COURSE IN GENERAL STRUCTURAL BOTANY.

This course is designed to acquaint the pupil with the most obvious facts and conditions of plant life.

Each student is provided with both a simple and a compound microscope, and with the more common reagents for testing for plant substances. An abundant supply of materials from the fields, adjoining gardens, florists and adjacent green-house is always at hand for the illustration of the subject under consideration. The work of this course is divided into two parts: first, lectures, and second, laboratory work. The lectures are given in a well-ordered room, where either the blackboard, artistic diagrams and charts, or the lantern can be used for purposes of illustration at a moment's notice. Living plants from the green-house form a prominent feature in the illustration of this lecture course.

The laboratory work is conducted in a large, airy room facing the north, eighty feet in length. Here each pupil has his own table, with gas, and a lock-case for his instruments and books.

The subject matter of the course may be said to be the comparative anatomy and physiology of plants. Each one of the plant organs is taken up in succession; its shape and structure are studied, first with the unaided eye and then by means of the simple and the compound microscopes. After the gross and microscopic anatomy is well understood, the attention of the

student is directed to the function. This becomes one of the most interesting as well as one of the most important parts of the study.

A general comparison of the organ or part under consideration with its homologues in all the great plant groups finishes the subject and prepares the student for the next exercise. In this way the root, the stem, the leaves, the flower and its parts, and the seed, are all subjected to careful study.

Under the root the following subjects receive special consideration:

1. Root growth compared with stem growth;
2. The organs of root absorption;
3. Root pressure, its causes and conditions;
4. Roots as aerating organs for the plant.

Under the study of the leaf the whole subject of plant assimilation or the formation of organic substances from inorganic materials is treated, as well as the equally important subject of plant respiration.

In the study of the flower the following subjects receive special consideration:

1. The relation of plants to insects;
2. The laws of inheritance as illustrated by plant development;
3. The distribution of plants through animal aid;
4. Cross and close pollination.

It will easily be seen that plants are looked upon and studied in this course as living organisms, and that the student handles and manipulates them for himself. This practical work prepares him for the next course, which deals with systematic botany.

# THE COURSE IN PLANT ANATOMY.

The students who enter the course in Histology are provided with all necessary apparatus for microscopic work, with the required reagents and such other conveniences as are found useful in securing the best results. As the course deals almost exclusively with microscopic work, the laboratory has been arranged with north light. Each student has ample room in lock cases and drawers for all instruments, appliances and preparations. Occasional lectures supplement the instruction and work in the laboratory.

The following presents a partial order of the lectures and practical laboratory work as it proceeds in the course:

1. Anatomy of the cell and its parts.
2. Contents of the vegetable cell.
3. Development of tissues from cells. The simplest forms; the more complex.
4. Study and classification of different kinds of tissues.
5. Study of the different systems of tissues.
6. Special study of the structure and classification of the fibro-vascular bundle.
7. Study of the minute structure and development of the root, the stem, and the leaves.
8. Study of the flower.—Morphology of the floral envelopes.—Morphology of the stamens, the pistil, the pollen, the ovule. Pollination.
9. Changes in the ovule due to pollination.
10. Development of the seed with dependent changes in adjacent parts.
11. An examination of the cell and its contents during the active period of division. Special changes in nucleus and protoplasmic contents.

A SPECIAL LABORATORY AND PROFESSOR'S ROOM.

The course opens with a thorough study of the parts of the living cell.

The examination of the structure and composition of the cell-wall, and the relation of its living protoplasmic membrane to the transfer of various cell-contents, receives especial attention.

The substances found in the cell are studied by means of their characteristic chemical reactions. The chemical work done under the microscope, combined with the careful study of tissues, their development and arrangement in the plant, gives the student an excellent preparation for later analyses of foods and medicines where adulterations are suspected.

A thorough knowledge of plant anatomy has aided much in the application of many vegetable substances to the arts, especially in finer papermaking and in electric lighting.

On the perfect understanding of the cell, its parts and contents is also to be based all future physiological study of the plant. In studying the development of the flower the most essential points in the latest methods of embedding in Celloidin are practised by the student. In this way all soft and delicate parts may be preserved and cut while in their natural position.

During the course each student is required to prepare 50 permanent slides illustrating the subject as fully as such a limited number will allow.

A prize of $25.00 is offered for the most carefully prepared suite of 100 slides best illustrating the subject matter of this course.

# THE COURSE IN VEGETABLE PHYSIOLOGY.

A word with reference to the scope of this course may not be ill-timed in this place.

Vegetable-Physiology deals with all the functions of the living plant, and with such external forms and condition as in any way effect its growth and development.

The plant bears certain definite relations to light, warmth, moisture, electricity and gravitation; also to all the various substances, including gases, liquids and solids, which may serve for its food or be in any way incorporated into its tissues. The fact that the human race is wholly dependent upon the vegetable kingdom, either directly or indirectly, for its food, that numerous diseases attacking man are directly due to vegetable growths, and that even the climate which gives strength or weakness is largely dependent upon the vegetation of the region, must necessarily tend to elevate vegetable physiology, which includes all that is known of the laws of plant growth, to a study of the very first importance.

It will thus be seen that Plant-Physiology lays the foundation for the consideration of the most profound questions touching agriculture, horticulture, forestry and sanitary laws.

No student seeking general culture, and no physician who may later be called upon to judge of healthful conditions of climate and food, can afford to overlook so valuable an aid as this.

The reproduction of the plant takes place under laws as well defined as the corresponding ones in animal life. To the

application of these laws in crossing species of plants, in budding, grafting, layering and growing from seed under varying conditions, we owe the most delicate of our fruits, the finest of our vegetables, and many of the handsomest of our flowers.

In order that the student may test all the conditions of plant life for himself, a well lighted, convenient laboratory must exist, with microscopes, spectroscopes, polariscopes, delicate galvanometers, and other apparatus for testing electric currents in plants, instruments for accurately measuring growth, apparatus for measuring the gases given off or absorbed by plants under varying conditions of heat or cold, light or darkness; dark rooms for growing plants without light, heavy scales for estimating transpiration, balances for making organic analyses, and many other similar appliances. In fact, the laboratory for the investigation of the life histories of living plants must be a well ordered chemical and physical laboratory combined.

Those particularly interested in this department of the University are at the present time collecting a fund for the special purpose of fitting up such a laboratory. The design is to make it equal or surpass in its fittings anything of this character at home or abroad. Already sufficient money has been given to ensure the success of the undertaking. The rooms and the whole outfit of apparatus and appliances will be ready for those wishing to take advantage of the course during the College year of '89 and '90.

The method of instruction will include both lectures and laboratory exercises, mainly the latter. That work is worth most, is most lasting and makes the deepest impression on the mind of the student which is performed by his own hand. A thorough insight is gained only through practical knowledge. The laboratory work is ordered with special reference to bringing all the experiments done in the room under the observation of every student.

Some of the more important subjects of discussion in Plant-Physiology may be mentioned as follows, each subject being capable of almost indefinite elaboration and experimentation:

Study of the living vegetable cell and its parts, including cellulose wall, protoplasm, nucleus, vacuoles and cell-sap.
Absorption of water and soluble substances; diffusion and osmosis carried on by the vegetable cell.
Transfer of water in the plant.
The relation of plants to the soil, and their surroundings with respect to food.
Assimilation; its conditions and products.
Chemical and other changes which take place in the plant.
Growth; its nature and conditions.
Movements of plants.
Reproduction.
Germination of the seed.

The following will illustrate the laboratory method followed in this course.

Taking GERMINATION OF THE SEED as one of the more simple and easy subjects, the following points present themselves for consideration:

1. External conditions of germination.
2. Physical changes in the seed during germination.
3. Chemical and other changes taking place in the seed during germination.
   (*a*) Forcible absorption of water.
   (*b*) Solution of nutrient matters.
   (*c*) Oxydation of substances.
   (*d*) Transfer of soluble matters to points of consumption.
   (*e*) Building up of new parts.
4. Vitality of the seed.
5. Power of the seed to resist external influences.
6. Germination of ripe and unripe seeds; questions involved.

Selecting for further illustration, the first point for which only there is space here, *i. e.*, EXTERNAL CONDITIONS OF GERMINATION, the following propositions to be studied by the aid of experiments in the laboratory suggest themselves:

1. Do seeds need moisture in order to germinate?
2. Do different kinds of seeds require the same amount of moisture?
3. Do seeds need warmth in order to germinate?
4. Do different kinds of seeds require the same amount of warmth in order to germinate?
5. Do seeds when germinating generate heat?
6. Do seeds require oxygen in order to germinate?
7. Do germinating seeds excrete or give off any gas during germination?
8. Do germinating seeds excrete $CO_2$ when oxygen is excluded?

In putting a class of students over such a series of experiments on GERMINATION, in order that the individual members may obtain the results and answers with their own hands, the topic in its broadest signification is given out to the class for reading and investigation from the literature of the subject. While the work is progressing in the laboratory, references to the literature most to the point are provided by the teacher. To each student is given, aside from the general literature of the subject, at least three or more of the experiments which follow under the head of TEMPERATURE, MOISTURE, or ABSORPTION AND EXCRETION OF GASES. The student is expected to carefully perform these experiments and at the same time to read and make notes, and when ready, with apparatus set up, bring all before the class, explaining the subject, showing his work, and giving his results and conclusions as far as possible.

After a student has explained his work and given the result, opportunity is offered to any member of the class to make suggestions and additions.

The topics as elaborated ready for the students are as follows:

## MOISTURE.

Do seeds require moisture in order to germinate?

[The following three experiments to be prepared at the same time by one person.]

Exp. 1. Four-o'clock and other seeds planted in pan of dry sawdust.

Exp. 2. Four-o'clock and other seeds planted in moist sawdust.

Exp. 3. Four-o'clock and other seeds planted in sawdust flooded with water. Keep the three pans at a temperature of 25° C.

Results: Seeds germinate in Exp. 2, but do not in Exp. 1 and 3.

Conclusions: Seeds need moisture in order to germinate. If they have too much or too little moisture they will not germinate.

Do all kinds of seeds require the same amount of moisture in order to germinate?

Exp. 4. Pan of sawdust only slightly dampened.

Exp. 5. Pan of sawdust made moderately moist.

Exp. 6. Pan of sawdust flooded with water.

Plant mistletoe, morning-glory and water-cress seeds in each pan and keep them at a temperature of about 20° C.

Results: Mistletoe only germinates in Exp. 4. All germinate in Exp. 5. Only the water-cress seeds germinate in Exp. 6.

Conclusions: Different seeds require different amounts of water in order to germinate. Some seeds, such as mistletoe, germinate with only a trace of moisture. Others, such as water-cress, will germinate in water, or in fairly dry medium.

## Temperature.

Do seeds need warmth in order to germinate?

Exp. 7. Corn, peas and beans planted in moist sawdust and placed in ice-box.

Exp. 8. Corn, peas and beans planted in moist sawdust and kept at a temperature of 25° C.

Exp. 9. Corn, peas and beans planted in moist sawdust and kept at a temperature of 75° C. in warm oven.

Results: Exp. 7 and 9 do not germinate. Only the seeds in Exp. 8 germinate.

Conclusion: Seeds need warmth to make them germinate.

Seeds will not germinate below nor above a certain temperature.

Do all seeds require the same temperature?

Exp. 10. Plant corn and water-cress in a pan of moist sawdust and place the pan in a box on ice.

Result: Water-cress germinates, corn does not.

Conclusion: Different seeds germinate at different temperatures.

Do seeds generate heat while germinating?

Exp. 11. Separate one quart of peas previously soaked for three hours in water into two equal parts. Place one part for ten seconds in boiling water and wash in weak solution of corrosive sublimate. Place the two lots in funnels under the same bell-jar, after inserting the bulb of a thermometer in the centre of each; also thermometer in the bell-jar. Arrange for free access of air. Note the temperature of each thermometer at once and again at short intervals for two or three days.

Results: Thermometer in dead seeds will remain nearly the same as the one in the air of the bell-jar. The thermometer in the living seeds will register from two to four or more degrees higher.

Conclusion: Germination (in this case) is accompanied with an increase of temperature.

## Presence or Absence of Oxygen.

Do seeds require oxygen in order to germinate?

Exp. 12. Two equal quantities of the same kind of seeds placed in moist sawdust under bell-jars and kept at same temperatures.

In one the oxygen is excluded by means of a constant stream of hydrogen gas or carbon dioxide. The second bell-jar is aerated by a constant stream of air.

Results: In the bell-jar from which oxygen is excluded seeds do not germinate. In the second, with free oxygen present, the seeds readily germinate.

Conclusion: Seeds must have free oxygen in order to germinate.

From Experiment 12 we learn that oxygen must be present when seeds germinate; also from Experiment 11 we learn that heat is produced at the same time. If the oxygen oxidizes some substance in the seed in order to produce this heat, we may expect to find $CO_2$, one of the products of oxidation, given off during germination.

Is $CO_2$ given off from germinating seeds?

Exp. 13. Place germinating seeds under a bell-jar, through which a current of air freed from all traces of $CO_2$ is made to pass by means of an aspirator. After the air passes over the seeds, allow it to enter a wash bottle of barium hydrate or potassium, in which the $CO_2$ will be retained and from which the amount may be estimated.

Result: Carbon dioxide is an excretory product from germinating seeds.

Conclusions: During germination the free oxygen enters the seed and oxidizes substances found therein. Heat is produced and $CO_2$ excreted.

After each member of the class has presented his topic, with the illustrated experiments, the class in general discuss and correct it, if possible.

A lecture by the professor in charge closes the series. The lecture is designed to criticise, arrange and put the work in order, to supplement any parts not fully represented, and to present such new matter as it may be necessary to introduce in order to make the subject complete.

The class is now ready for the next series of experiments; the same method is continued through all the work.

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In the advanced course in Plant-Physiology a wholly different method is followed. Each student works for and by himself. The course is individually marked out, in accordance with the requirements of each person.

# THE COURSES IN SYSTEMATIC BOTANY.

During the second term, Professor Rothrock will give one lecture each week on the orders of the Phænogamic plants, including the structure, uses and distribution.

Associated with these lectures there will be laboratory work each week, in which classification and analysis of the Phænogamic plant will be taught. It is intended that the lectures and the laboratory work shall each supplement the other.

The institution possesses ample facilities for full illustration, by diagrams, material, and instrumental appliances.

This course, though complete in itself, should be preceded by that given during the first term, on the organs of flowering plants, by Professor Wilson. The relationships of the plant to its surroundings, or, in other words, the influence of soil or water, temperature, humidity of the atmosphere, etc., to the form and life habits of the plant, receive due consideration. It is hoped to give, by this course, a definite idea of the sequence of the chief events in the development of our plants. To ensure thoroughness, students must observe (with flowering plants) the following order in examination, and at the same time make notes and drawings.

ROOT.—Is it annual, biennial, or perennial in duration? What is its form, size, color or consistence; simple or branched? State method of branching.

STEM.—Size, shape, herbaceous or woody; exogen or endogen;* duration; mode of branching; surface, *i. e.*, is it smooth, rough, hairy, or what are the characteristics?

* We still prefer to use these somewhat antiquated terms because of their general convenience.

LEAF.—Position on stem; simple or compound; outlines; character of surfaces, of margin of veining, of tip and of base; petiole, present or absent; stipules, present or absent; are upper and lower leaves alike or unlike; if the latter, how do they differ?

INVOLUCRE.—Character of brachts in one or more series. What are their relative lengths; shape of tips and mode of imbrication?

CALYX.—Shape; sepals distinct or united, shape of, color, size; free from, or adnate to ovary?

CAROLLA.—Shape; petals distinct or united, shape of, color, size; from what organ do they spring?

STAMENS.—Number; relative size of insertion in relation to petals and to each other; anthers, size, shape, number of cells, mode of opening, mode of fixation, sessile, or on filament.

PISTIL.—Number, size, simple or compound; styles, number and length of; included or exserted; stigma, number, shape and character of surface; ovary, free or adherent, number of cells in, mode of placentation, *i. e.*, central, freecentral, or parietal; ovules, number and shape of, number of seeds. How does the mature seed-vessel differ from the young ovary? Give characteristics of seed, external and internal.

INFLORESCENCE—Is of two classes.

1st. Racemose, in which the oldest flower is below and the youngest above; but no flower exactly terminates the main stem or branches.

2d. Cymose, in which the oldest flower is on the end of the main stem and the later flowers on the ends of the branches. The racemose class has the following chief varieties:

*a.* Axillary, where the flowers are in the leaf axils.

*b.* Spike, where the sessile flowers are arranged around a central axis.

*c.* Raceme, as in the spike, save that the flowers have each a foot-stalk.

*d.* Panicle, as in the raceme, save that the foot-stalks branch and bear flowers.

*e.* Corymb, a raceme in which the foot-stalks are elongated so that the flowers all reach about the same height.

*f.* Umbel, like a corymb, except that the foot-stalks spring from the same level around the stem.

There are various other modifications of the racemose plant.

The cymose class has:

*a.* Solitary flower on end of stem.

*b.* Cyme proper, a flat-topped cluster with the oldest flower in the centre. This type may be variously modified by unequal length of flower-stalk, by regular suppression of branches, either on same or on alternate sides of main axis.

To which of the above varieties does the flower in hand belong?

GENERAL CONSIDERATION. — Is this plant perfect, monœcious, diœcious or polygamous? Is it in any sense dimorphic? If so, specify how. Does it show any deviations in form or structure from a complete, regular, or symmetrical flower? If so, what; and for what purpose does the deviation appear to exist? Has it nectaries, odor, or other special attractive characters?

There is, however, another view from which systematic botany may be considered, *i. e.*, as a means of education or mental training. Probably no branch of science cultivates more closely habits of exact observation. Failure here means failure in result, and hence a faulty observation immediately declares itself by failure to obtain the name sought.

Such logicians as John Stuart Mill and George Bentham have found constant exercise for their powers of observation and generalization in the field of systematic botany. Hence, then, as an element in mental culture, and quite apart from the facts taught, its value must be recognized.

In all instruction in systematic botany, this educational value is remembered, and an attempt is made to obtain the largest results in that direction.

By way of illustrating methods of teaching, the following report is made from the work of the senior class, on Thursday, February 23d, 1888:

This statement was made by the Professor in charge, that "*Variation, instead of being an unusual character in plants, is so common that Dr. Hooker declared there were more species which could not be strictly limited than there were those that could be.*" The question before the class was, Is this statement true? There were nine students present, each of whom had the same

plants given him for examination. The first plant proved to be Cuphea viscosissima, Jacq. Comparison of results showed that in this plant the number of petals varied; thus, 4, 5, 6, or as stated by Gray they were sometimes wholly or partly wanting. Of stamens, there were in one flower 11 and in another 12, and one examined the previous day, 20. The ovary was found to be one or two celled.

The second plant on examination proved to be Cunila Mariana, or the common dittany. In this the chief variability was found to be in the number of stamens. Two was known to be the normal number, but one gentleman found four and a well-marked rudiment of a fifth. Here was a decided departure from the usual plan of the flower. Another found one rudimentary stamen in addition to the two perfect ones.

*Question repeated: Is or is not variation to be regarded as common among plants?*

*Answer: Yes, so far as these plants indicate.*

*Question: Why is it not more generally recognized?*

*Answer: Because a single observer must examine a large number of species and many individuals of each to establish such a proposition.*

*Question: Why should the dittany show a tendency to have five perfect stamens?*

*Answer: Because five is the ordinary number of parts in the floral circles of the flowers of exogens, and this is simply a partial return to a form from which the dittany was probably derived.*

The inference was drawn, that if evolution is based upon a tendency to variation, then these plants tend to confirm the doctrine of evolution, though the extent to which it is accepted must depend upon a large body of facts and the individual estimate placed upon those facts.

In illustration of the terms species, genus, order and

alliance, Lobelia inflata was first analyzed. Then Lobelia cardinalis and Lobelia syphilitica were compared with the first named species. The class then gave their own ideas of the the term species, and drew up in writing a statement of the generic characters of Lobelia. From this the American genera of the order of Lobeliaceæ were considered, and the description of the order written.

To obtain an idea of grouping of orders into a larger alliance, the structure of the Compositæ was next considered, and the ray flowers of the latter explained as a transition from the tubular flower to the split corolla of the Lobelia. The united anthers and adherent ovaries in the two orders under examination, showed the relation of one order to the other. From the recognition of these facts, must of necessity come the conclusion that throughout the vegetable kingdom there runs a unity under law.

In the second term of the second year Professor Rothrock will lecture once each week upon the (so-called) cryptogamic plants. The lectures will be a continuation in plan and scope of those given by him in the first year. There will be laboratory work, and beside the mere study of forms and structure an attempt will be made to bring out such principles as may tend to give a certain unity to the whole group of flowerless plants. Thus, two leading ideas are kept in view: first, the constantly increasing importance of the sexual organs and functions as one proceeds from the lowest to the highest division; and second, the increased protection accorded to the spores in proportion to the reduced number produced. The significance of the non-sexual and sexual methods of reproduction will be fully explained, and the methods of each given in detail.

It might be proper to state here that the institution has five collections of cryptogamic plants available for study and comparison.

In the last year the instruction given by Professor Rothrock begins with the second term. The most of the time is devoted to work of practical character; thus, to those students who contemplate the study of medicine, such plants are given as have either a recognized place in the dispensatory or have such a popular reputation that it is to the advantage of the physician to recognize them, and it is expected that the student shall not only know the plant, its structure and place in the system of classification, but its real or reputed properties as well. Or if the student should prefer to investigate the various forms of food adulteration, his studies may take that direction. It is not known to the public, or even to the physician always, how frequent such adulteration of the food derived from the vegetable kingdom is, and that in many, if not in most instances this may be detected by the microscope, or by some simple chemical and microscopical examination combined. Hence the importance of a more general knowledge of this branch of economic botany.

Another line of instruction is opened to the third year students in botany in their last term, *i. e.*, the microscopic structure of the various kinds of wood used in the industrial arts. It is now clearly recognized that such properties as weight, strength and resistance to splitting can be explained by microscopic structure, and that often it is a matter of practical importance to have the benefit of such knowledge. Hence then the benefit of training in this direction, especially to students who propose to adopt an avocation in which such questions as grow out of the physical qualities are continually arising. The institution is provided with abundant material for the prosecution of these studies, and an attempt will be made to render the instruction distinctly practical.

It is of course quite unnecessary to dilate upon the importance of a general knowledge of botany to the physician,

but it is often a question where such training as will fit one for investigation of the life histories of those lower forms which modern science has shown to be so largely concerned in the causation of disease can be had. To students who are prepared for this work, and who have shown aptitude for it, suitable aid will be given. Beside diseases peculiar to man, and which the lower plants are active agents in producing, plant diseases are often caused in like manner by other vegetable foes. In these the agriculturist, horticulturist and forester are interested. Study of these foes in a well-appointed botanical laboratory is a most important aid to further investigation, which the trained student may follow up with advantage in future. This field is one of constantly increasing importance. It is also one of the most fascinating and at the same time one of the most difficult, and involves constant attention to details on the part of the student.

In Botany, the student who comes simply to remain two years and take a certificate instead of a diploma, will enter the Sophomore class work, and take his second year with the Junior class, though he will probably be given more hours weekly of Botany than those who take the College Course in Natural History, which is one of wider range and which leads to a diploma in four years' study.

IN THE PHYSIOLOGICAL LABORATORY.

# THE COURSE IN PHYSIOLOGY.

Aside from the fact that general knowledge is of value to every one, the study of physiology possesses still other and more important claims for recognition as an advanced and useful branch of learning. Very few of the present generation have any idea of the functions of their various organs, and as a consequence neglect them entirely, or what is worse, maltreat them in health and disease.

Every physician sees persons constantly who have materially injured their bodies by ignorance of the simple laws of health, and it is a notorious fact that the man who treats himself for any ailment comes finally to the physician in a worse state than the individual who leaves himself alone and allows nature to take its course.

Heretofore we have trained the young in every branch of science and art, but no attempt has been made to teach the functions of the body.

The average mechanical engineer leaves college with his degree qualified to repair the most intricate part of a locomotive, wherever he may find it, but absolutely ignorant of how to take care of himself should accident overtake him. Such examples might be given indefinitely, and if one will but pause for a moment to think he will see that so-called preventive medicine applied by each one of us to ourselves would save in the course of a year thousands of dollars which are lost, since otherwise educated men are disabled because they attempt to carry

on a successful business without knowing how to care for the power which keeps it going, namely, themselves.

Very frequently bitter experience teaches the old, and more rarely the young, some of the laws of health and normal bodily function, but more commonly this lesson comes too late.

In the Course in Physiology in this department of the University these facts are constantly borne in mind, and while the lectures are strictly confined to animal physiology no opportunity is lost in which a practical side of the study may be brought forward. No attempt to teach "emergency surgery" or kindred topics is made, but the student knows why be should apply cold to a fellow suffering from sunstroke, why he employs certain methods in the resuscitation of the drowned, and why he should not give stimulants to every one who faints from loss of blood until at least the leaking blood-vessel is ligatured. These are the practical sides of the course.

The scientific part of the question is almost equally important. Primarily it gives the student the ability to analyze the functions of many animals and species, to think deeply upon things which ordinarily are too superficially passed over, and gives him a mind trained in lines of thought which are valuable to the scientific advancement of the world.

Taking the young man at the time when his inclinations are most easily moulded it turns his thoughts toward original scientific discovery, interests him because of its practical bearing, and finally puts him in a position from which he may rapidly become a physiologist in name and deed, and in this way a benefit to the world at large.

# THE COURSES IN PSYCHOLOGY.

These courses have been added to the department during the present year. Both physiology and psychology are concerned with the phenomena of life, and it is a misfortune that in the past the two sciences have been kept so far apart. It is hoped that the addition of psychology to the department will be a double gain. On the one hand, students of biology will be enabled to study systematically mind and its relation to the body; on the other hand, students of philosophy will be shown that psychology is a natural science, resting upon experiment and scientific observation.

The Courses in Psychology have the same ends as the other courses of the department—the education of students and the advancement of knowledge. For both of these purposes such a course is needed. The study of psychology in the laboratory teaches accurate observation and correct reasoning in the same way as the other natural sciences, and the recent introduction of experimental methods has opened up a broad field for research. Courses of lectures and laboratory work for both elementary and advanced students have been arranged, and research work will be especially encouraged.

Throughout the course special stress will be laid on laboratory work done by the students themselves. They will first undertake a systematic series of experiments under the direction of the Professor, and will later be given some special subjects where experiment will enlarge our knowledge of the mind. Advanced students will be encouraged to find for themselves problems and the methods for their solution. Students will be

expected to write accounts of observations and experiments which they have made, and these will be read before the class and discussed by it. The lectures given by the Professor will not be of a formal nature, discussion being encouraged. The following courses will be given next year. The courses are arranged for three years, but students may select certain parts, or do the work of two years in one.

| | | |
|---|---|---|
| Scientific Methods in Psychology, with laboratory work, | 2 hours, | 1st term. |
| Experimental Psychology, with laboratory work, | 2 hours, | 2d term. |
| Special Psychological Problems, with research, | 2 hours, | 1st term. |
| Comparative, Social and Abnormal Psychology, with practical work, | 2 hours, | 2d term. |
| Advanced Psychology, | 2 hours, | 1st and 2d terms. |
| Research in laboratory, with supervision, | daily. | |
| Seminar, | weekly. | |

The course begins with some study of scientific methods. This includes subjects such as observation, experiment, measurement, analysis, classification, etc., and the range and relation of the different sciences. Special attention will be given to laboratory work done by the students themselves. This course might be useful as an introduction to any science. It will, however, be arranged with special reference to experimental psychology, which will be taken up in the second term. In this course the nervous system in its relation to consciousness is first reviewed, and then the mutual relations of the physical stimulus, physiological mechanism and sensation for the different senses. Thus sight, hearing, smell, taste, touch, temperature, sense of

effort and organic sensation are successively taken up. Perceptions are analyzed, and especial attention is paid to the measurement of mental time, intensity and range. Series of experiments are then made on attention, memory, volition and the train of ideas.

During the first term of the second year some special psychological problem will be taken up, and students will attempt to learn all that is known concerning it, and will at the same time make experiments which will enlarge our knowledge of it. The subject will be different each year. In 1890 it will either be *Memory* or *The Time taken up by Mental Processes.* In the second term there will be a course of lectures and practical work in comparative, social and abnormal psychology. This will include subjects such as mind in the lower animals and in savages, the development of the child's mind, customs and institutions, language, dreams and hypnotism, paralysis, insanity, etc. The course will be as practical as possible, experiments being made, clinics visited, etc.

The advanced course leading to the degree of Ph.D. will be arranged to suit the needs of students. Lectures will be given in advanced psychology, but students will be encouraged to study especially in the direction which they consider most important and interesting. Those taking the subject as a major study must do original work fit to be published. Facilities will be given to teachers and men of science wishing to use the laboratory for research or to examine the methods used in the course.

A convenient laboratory for teaching and research has been fitted up. It contains the apparatus needed for the different courses, and several valuable sets for original research. The collection is at present being enlarged by gifts from Trustees of the University and others interested in the course, and it is believed that it will soon be the most complete in the world.

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